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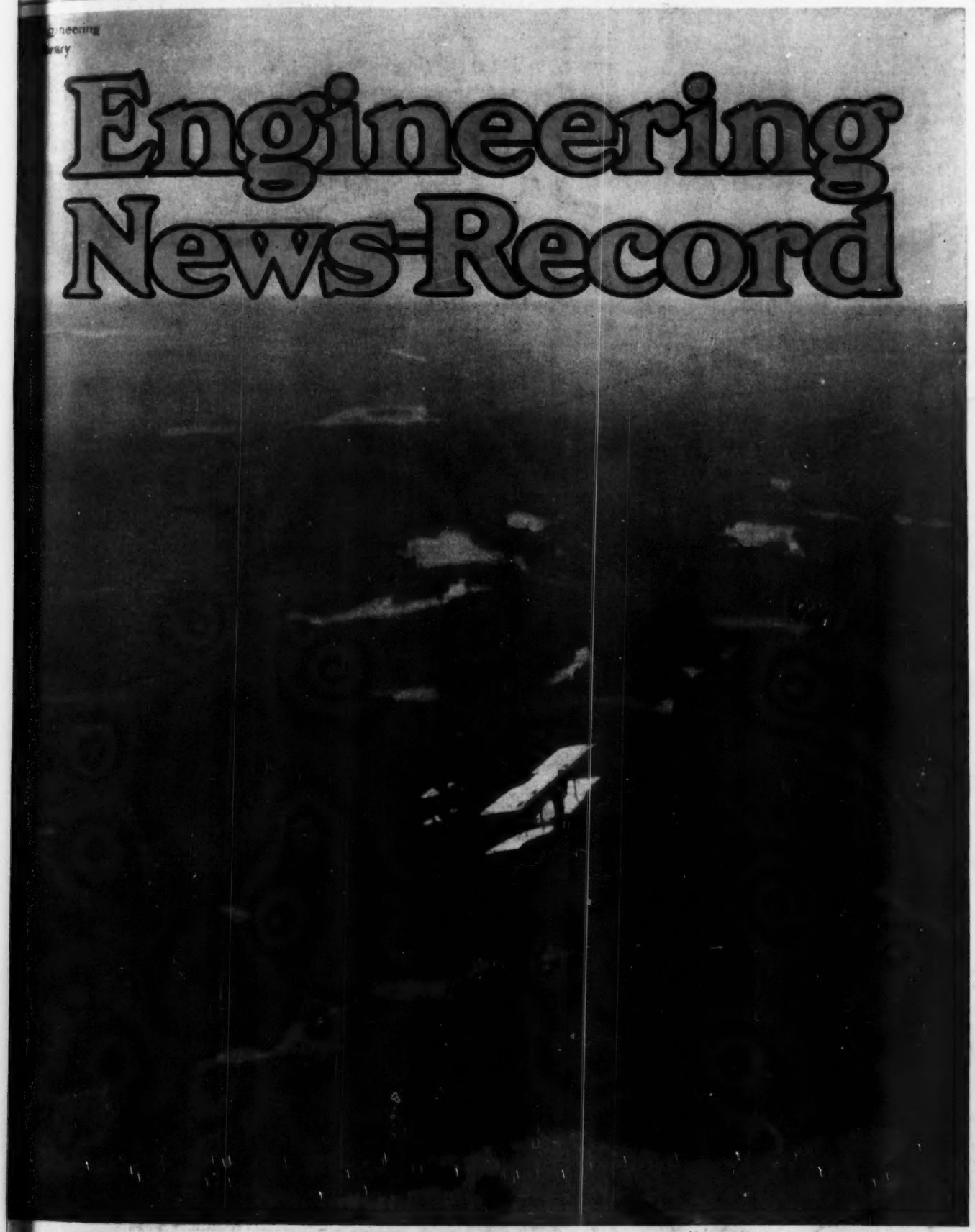
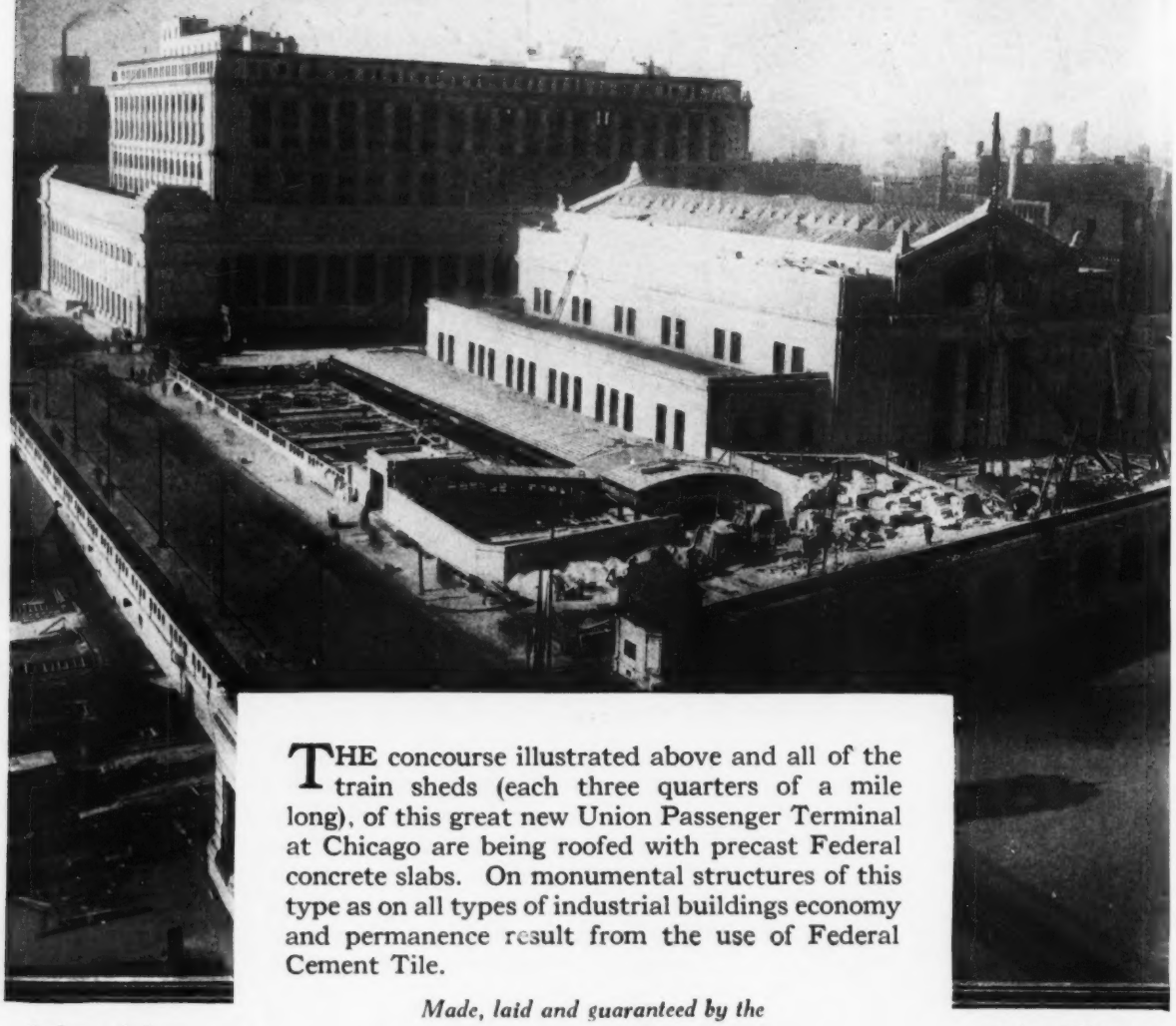


The Engineer Takes to the Air

Railway Reconnaissance in Northwestern Quebec

Chicago's New Union Station is Roofed for Permanence



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Volume 94 New York, February 5, 1925 Number 6

Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS, ENGINEERING RECORD, AND THE CONTRACTOR

FRANK C. WIGHT, *Editor*

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From Secretary Herbert Hoover

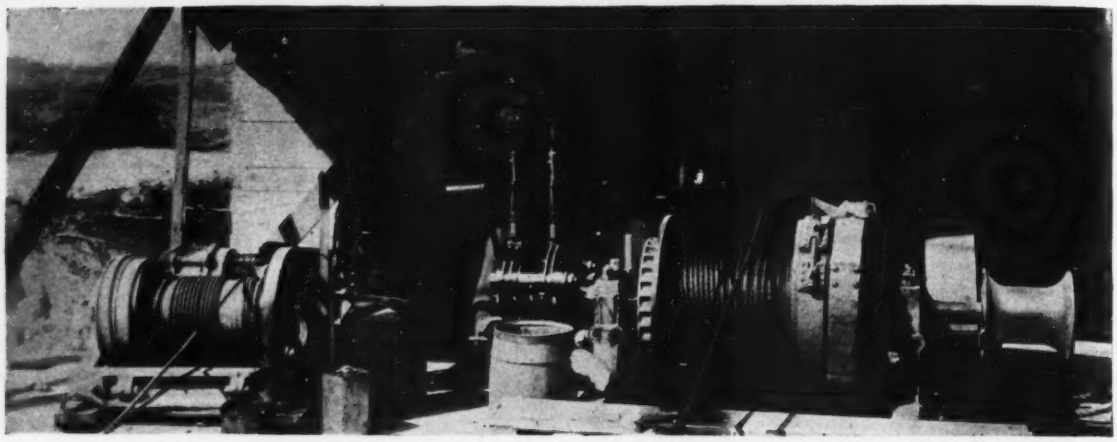
Herbert Hoover, Secretary of Commerce, sent the following message last week to James H. McGraw on the occasion of the annual sales conference of the McGraw-Hill Co., Inc., concluding with a dinner at the Hotel Pennsylvania, New York, attended by about 300 members and guests of the organization:

"I wanted to attend your convention to say a personal word of appreciation for the fine service which you, your company and your publications are rendering to American industry. It is a real disappointment to me that I cannot come.

"A big change has come in the spirit of American business and for this change you are in part responsible. I mean the change from rule-of-thumb and *laissez faire* to scientific determination of facts and programs of action based on facts. The business press is probably the greatest force in making industrial opinion. The schools and colleges have an important place, the trade associations can do much in the fields of production and distribution, the government bureaus which keep in contact with business can help to promote sound leadership in industrial and economic thinking. All have an important place, but the business press and technical journals are in a unique position and have a unique opportunity. I believe that no organization of technical publications has come nearer to living up to this opportunity than the McGraw-Hill publications under the leadership of James H. McGraw.

"The thought that I have in mind is that your great group of journals can not only recognize and support sound industrial leadership; you can also initiate it. The field of your opportunity is practically limitless."

Herbert Hoover



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ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 94 NEW YORK, FEBRUARY 5, 1925 Number 6

From Canoe to Airplane

TO THE young engineer who adopts the newer method of examining a wilderness and takes an airplane to fly over it his work cannot be without its thrills, but when the seasoned reconnaissance engineer, well knowing the hardships of the older methods, the hands blistered by tedious paddling and the back wearied by long portages, lays aside these slower means of travel and takes an airplane for a survey of untraveled country, the thought of what his experiences must be as he crosses in a few hours over a route that takes many days by canoe and on foot, must stir the imagination of the most unromantic. Such an experience recently came to H. K. Wicksteed in locating a railroad across the trackless highlands of western Quebec. Elsewhere in this issue he tells of his work and gives his opinion of the advantages as well as the shortcomings of the airplane as an aid to railroad reconnaissance. With some men the picturesque side of the story might be lost in the recounting even though the valuable engineering details were brought out. But such is not the case with Mr. Wicksteed's account for he writes with a facility all too uncommon among engineers. His enthusiasm for his work, for the country, and for the projected railroad makes his story well worth reading even if it were not written by an engineer long experienced in the art of railroad location and reconnaissance.

The Professional Conscience

UNDERTAKING to solve a client's engineering problem nearly always involves certain peculiar difficulties of partly psychological nature. The engineer must determine what the client really wants, and how his wishes can be satisfied in a technically sound way—with regard to safety, esthetics, permanence, and similar factors in addition to economy. The client's own statement of what he wants is only one of the data in the problem. The rest of the solution must be supplied by the engineer himself. The nature of the reasoning as applied to problems in steel building construction is outlined in an article on p. 236 of this issue. As there set forth, it may seem to apply only to steelwork, but we believe its real scope is almost universal, so far as engineering activities are concerned. Mr. Coyle's statements really put a problem, however, rather than solve a problem. They are an invitation to the engineer, in every field of activity, to review his relations toward clients and others from the viewpoint of his conscientious responsibilities. He must determine to what extent he is willing to do both poor work and good work according to the demands of the client. Or, more corectly speaking, he must decide what limit he will set himself in attempting to meet the requirement of maximum economy which may be imposed in one or another problem. He must decide also how he shall carry out his work on these maximum-economy cases without running the risk of debasing his technical judgment and endangering the quality of his work in other cases where the demands of economy are less extreme. The field of thought opened up by the discussion of the structural engineer's problems is in fact remarkably wide and yet is of vital personal importance to every engineer.

New Light on a Stress Problem

ENGINEERS have always differed on the question of how to interpret local stress concentrations in a structural member. Structural steel design has been particularly a field for such differences of view. One extreme attitude was that stress concentrations such as occur around rivet holes or at the root of a sharp bend or notch are to be counted at full value in estimating the tax upon the material, and in fact should be rated even more important than their numerical value because of their tendency to bring about such failure under oft repeated stressing or under shock. The other extreme was a virtually complete disregard of the local concentrations. Experimental data are now brought forward which give an answer to one part of the problem. As Prof. H. F. Moore brings out in this issue, local stress concentrations do *not* have the full fatigue effect which their numerical value would indicate. Resistance to repeated bending (millions of repetitions) is lowered by the local overstress, but the lowering is less than would correspond to the calculated stress increase. This means that the truth is intermediate between the extreme views. The engineer is justified in discounting localized overstress, but cannot safely ignore it altogether. This applies so far as the danger of fatigue failure is concerned. We believe that it is true in somewhat similar manner of resistance to shock, so long as the material is ductile and homogeneous. The ability of soft steel to deform and readjust by plastic yield is, in fact, the essential safeguard against various possibilities of failure or damage not directly taken into account in design calculations.

Road Grading Efficiency

ANALYSIS of construction operations have been rare in the research work of public works bureaus having direction of roads and streets construction. The fact is worth particular notice therefore that the federal Bureau of Public Roads has ventured successfully into this unusual field of research study. So far the study has been limited to earth moving operations and to grading methods of the simpler sort. As a result, however, grading contractors have information extending well beyond the limits of common personal experience on fresno scraper and wheel scraper operation, including a special record of the economics of haul. The

second of these studies on fresno scraper operation is summarized in this issue. The first study on economical length of haul was published in the issue of Nov. 20, 1924, p. 832. A future article will epitomize the wheel scraper findings. This specific announcement of these articles is made because it is important that contractors should read them. Indeed it is urged that they provide themselves with the complete reports of which the articles in the isues indicated are necessarily only summaries. And it is urged again that contractors shall be free in their criticism of the deductions about which their experience makes them doubtful. There is a two-fold reason for this scrutiny and comment. The true facts are wanted as a matter of research accuracy. More important, however, these earth-moving studies will inevitably be taken as a measure of efficient performance and so will react on the engineer in his estimate of fair contract prices for road grading.

Highway Snow Removal

COMMENTING on snow removal from highways the committee on maintenance of the Highway Research Board in its last report, asserts that "a large amount of money is being spent for this work with little regard to economy." Apparently the lesser item of economy of removal methods and not the greater item of traffic economy is referred to in this statement. That it is largely true no one can doubt and that the condition should exist can hardly be wondered at. Few states keep their roads cleared of snow at all comprehensively and in none is the practice more than a few years old. Under the very worst snow conditions snow removal occupies only a comparatively few days in the year's road work. Nevertheless snow-removal economics need to be studied. Indeed it is clear that maintenance engineers are called to go much further than consideration of removal methods and give very serious attention to drift prevention. If drifting on the highway can be stopped, the equipment problem is much simplified, which is a very important object in the case of a plant which gives only a few days service in twelve months. A few states have done some snow fencing but generally drift prevention is disregarded on the greater portion of the 20,000 miles of highway now in some measure cleared of snow each winter.

Engineering and Modern Selling

LAST week the McGraw-Hill Co., the publisher of *Engineering News-Record* and 14 other technical and industrial journals, held an organization conference in New York. It was a sales conference, a getting together to discuss ways and means of better merchandising of the product that the company has to sell, but better merchandising means always better production as well as better distribution. To that extent the readers of this journal have an interest in what that conference will eventually effect, though such an interest is not obtrusive. But aside from that the conference would have interested every engineer had he been there and had he been able to see the far end to which it tended. For through three days of rather intensive discussion it became increasingly evident that industrial merchandising is a part of the great cloth through which are woven the threads of engineering endeavor and that the stability of the whole cloth is affected by and likewise affects the stability of each its parts.

Engineers both make and use industrial products. Because of the brilliancy of group engineering effort through the past half-century, the production of things has become relatively simple. What we want we can make, and as new needs arise our equipment is such that we can readily satisfy them. Not that it is easy for the unlearned beginner to undertake such production, or that the labor of brain and hand of the learned is immaterial, but there are men available and there is knowledge available which joined together can solve the problems of production. But production, as we noted above, is not all; there must be effective consumption, and consumption requires not only an intelligent and informed consumer but also some means of getting the product to the consumer at a cost which he will pay at a profit to those who undertake to supply him. Here is the problem of distribution—the great economic problem of the immediate future. And the engineer is vitally concerned with this problem, not only because his very existence depends on the extent of the ultimate consumption of that which he produces, but also because he himself in producing these things is a user of other things, on the price of which and availability of which depends the cost of the things which he builds and therefore the demand for his services in building them.

It is a fairly trite remark today that these problems of distribution must be solved by engineering methods, that the elimination of waste, the careful ascertainment of predisposing fact, the application of proved rules to such fact once ascertained, in other words the well known mental tools of engineering are needed in distribution more than any one thing. But an engineer listening to the discussions in the conference and noting the way the salesman is learning how important is this kind of thinking must have concluded that the engineer has a more direct concern with the problem than in merely opening up for himself a new opportunity and a new field. In its proper solution there may lie the solution of some of those things we have been classing rather pessimistically under the general head "the status of the engineer."

The engineer is underpaid, the engineer is underrecognized—that we know. How much of it is due to this very fact that we can produce so readily—whether that production be bridges or automobiles or underwear —and we distribute and sell with so much difficulty and with so much human machinery. And when the engineering mind and the engineering method begins to function more effectively in forging this last link in production's chain, engineers will profit, not only insofar as they are consumers, ultimate and intermediate, but also by the leveling of the now disproportionately lower reward the world gives to those who produce as compared to those who sell. Some, at least, of the economic profit that should result from the application of the engineering method to distribution, should flow back to those whose training and experience make this economic profit possible.

There may be no promise here of raised incomes for individuals or for immediate elevation of the depressed "status" just mentioned. Here is probably nothing readily convertible into dollars and cents, but in the long view it has its significance that should not escape

the attention of the thinking engineer, and for that reason the thought is thrown out tied to the report of these discussions of how can best be made utilizable a product made by engineers for engineers—that is technical periodical literature.

Vindication at Last

TWO years ago last December the United States Department of Justice brought to a climax its long staged campaign of villification of those responsible for the war construction program of 1917-18 by procuring in the District of Columbia an indictment for conspiracy to defraud the government against seven members of the Emergency Construction Committee of the Council of National Defense which had control of the letting of war construction contracts in the early days of the Great War. These men, all prominent in the construction industry, were Benedict Crowell, of the construction firm of Crowell-Lundoff-Little of Cleveland; Clemens Lundoff, his partner, William A. Starrett, architect and engineer of New York; Clair Foster, long prominent in building contracting in New York City; Morton C. Tuttle, at the time general manager of the Aberthaw Construction Co. of Boston; James A. Mears of the construction firm of Fred T. Ley & Co., and John H. McGibbons, a representative of a Baltimore bonding concern. These were the men directly charged with that basest of crimes, the defrauding of their government in time of war, but accused with them though not by name or by specific crime, were all of the engineers and contractors who were connected with that wonderful construction program of 1917 and a dozen or more of the leading engineers and architects of the United States who had approved, after formal investigation, the operations which later the government sought to brand as criminal.

All this is well known to the engineers and contractors of this country; never since this official attack was started have they believed in its sincerity or in the validity of its charges, they have known that the political strategy of the post-war period made necessary or, at least, seemed to some politicians to make necessary, a depreciation of the war effort and since the war had been won and since, too, they knew the American people were in no mood to hear attacks on the military conduct of the war, there was left nothing but those civilian activities where money was spent. Hence the drive against the contractors and the engineers who put through in three short months the greatest construction program the world has ever seen.

There never was proof of guilt against these men, but all of the power of a government department, and all the legal ingenuity of shrewd attorneys, was brought into play first to insinuate guilt and later to delay justice. The service of the government was prostituted to personal aggrandizement and political gain, and, temporarily, a group of honest men, and through them the industry they represented, were pilloried as traitors and thieves and forced into heavy expenditure to defend themselves.

The infamy has dragged along for two years, the accused fighting for a fair and speedy trial, the accuser delaying and postponing but step by step being defeated and falling back. The final step has now been reached. The attorney-general under whose sinister direction this persecution was initiated was forced to retire and in his place came an honest and fair-minded lawyer who was not prejudiced by the past or influenced by political needs. Harlan Stone has at last repudiated Harry M. Daugherty and has ordered the abandonment of any further persecution of the Emergency Construction Committee. The text of the order is technical; its apparent animus is the legal impracticability of the indictment. But the real idea back of it is apparent. Benedict Crowell and his associates committed no crime, the charges against them were worse than ridiculous and they would hold no more weight in a court of law than they ever held in the hearts of the men of the construction industry who knew what was done in that summer of 1917 to make sure that the then unrevealed campaigns of the summer of 1918 could be carried through to their victorious conclusion. Vindication has come at last—but it has come very late.

Allotting Interstate Water

FORTUNATELY the Constitution of the United States, in its general prohibition of treaties by the states, made an exception permitting and providing a way for treaties between two or more states, subject to approval by Congress. Already there are 32 such treaties, and at least two of them deal with interstate waters: Colorado-Kansas, with the use of such waters for irrigation, and the Minnesota-Dakotas, for flood protection and drainage. The latest, and one of the most important, is the New York-New Jersey-Pennsylvania compact for the utilization of the Delaware which has just been submitted to the legislatures of the three states by the tri-state commission that formulated it.

The allotment of interstate waters presents one of the most complicated problems in our government and law and it is one of the most serious of the problems of our future. Not only to decide the relative rights of the various owners and the several states but also the superiorities of demand of the various uses, puts existing law and processes to an impossible test. The interstate treaty seems the only way out, short of complete federal control, which would require a torturing of the Constitution out of semblance to its present self. The Delaware compact is a good example of how the difficulties of the case may be eased.

Beneficiaries of the compact will number ten million at the outset and twice that number in a few decades. It not only opens the way for solving the water supply problems of Greater New York, the North Jersey Metropolitan District and Philadelphia for the next century but it will facilitate hydro-electric developments and may be an aid to navigation. Forest conservation as a means to the three main ends of the compact, is named as one of the functions of the permanent commission and the sanitary protection of the Delaware River is the subjects of several notable paragraphs. Thus it will be seen that all of the uses of flowing water except irrigation are involved in this agreement.

The test of such agreements will come in their operation. In the case of the Delaware there is set up a permanent tri-state commission with large powers of administration and license and extensive possibilities of investigation. None of the water of the river can be utilized without the consent of at least two of the states acting through their representatives on the Commission. But the basic principles of utilization—that is that only flood waters may be diverted, that proportionate use is required of each of the states, and that purity of the water must be maintained—are clearly laid down.

Making Railway Reconnaissance Surveys by Aerial Methods

Surveys for the Abitibi Southern Ry. Made Through Forested Area of Quebec by Airplane—Advantages and Disadvantages of the Method—Peculiar Characteristics of the Country

By H. K. Wicksteed

Consulting Engineer, Formerly Chief Locating Engineeer Canadian Northern Ry., Toronto, Ont.

Developing new territory by the construction of a railway into it is by no means a new story on this continent, but the methods adopted in making the preliminary surveys for such a railway, now projected in Quebec, are decidedly new. Airplanes were used for reconnaissance and in preparing the maps. As this is the first instance in which this method of observation was ever used for such a purpose, the following comment by one of the most experienced railway locating engineers on the continent is exceptionally interesting. Mr. Wicksteed for many years was connected with the location work of Canadian railways, both private and government-owned. The story he has written here is a vivid contrast of the old and the new in a major engineering operation.—Editor.

TO THE NORTH of the Ottawa and the St. Lawrence and of Lakes Superior and Huron is a great forest wilderness known as the Laurentides or Laurentian range. Geologically it is composed of some of the oldest rocks known, and it is certainly the oldest portion of the North American continent.

The southern outcrop of these rocks is for the most part extremely bold and rugged, which gave rise to the name Laurentian "mountains." As a matter of fact it is much more of a tableland than a mountain range, and few of its hilltops attain a height of 3,000 ft. above sea level. As we proceed inland the summits of these ragged hills do not increase in elevation, rather the reverse, but the valleys fill up very rapidly at first, then more slowly as we proceed, and the rivers and streams, at first mere torrents with numerous falls and rapids, gradually flatten out in grade until many of them become sluggish streams meandering aimlessly about the country. During its immensely long history it has been subjected to all sorts of rough treatment. Ice and snow and intense cold have disintegrated its surface rocks, hard as they are. Pressure from without has contorted and distorted the strata, glaciers have coursed slowly down in bygone ages and have carried the debris of disintegration far to the south, even into the states of New York and Ohio.

In historic times this forest wilderness played a part of paramount importance in Canada's development. The earliest colonial population earned a living by trapping and trading in the skins of wild animals, notably the beaver, which, until recently, was the emblem of Canada and still appears in some of the heraldic designs. Early agricultural development was nearly all on soils derived from it and followed the course of its streams and rivers. In later years of development the pine and spruce of this forest became the principal industry of the country and brought millions of dollars into the pockets of the settlers and to the public treasury. The Laurentian rocks, wrinkled and twisted as described, developed numberless pockets and basins, the forest growth encouraged a liberal rainfall and the pockets filled up and overflowed into others until the plateau became over vast areas a labyrinth of lakes and connecting streams, and these again in their turn united to form great rivers such as the Ottawa, Saguenay, St. Maurice, Manicouagan and a host of smaller ones.

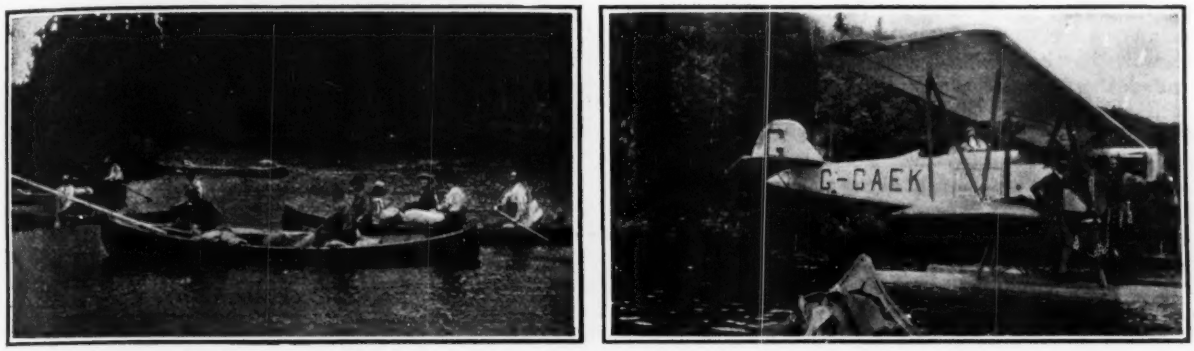
About the same period as the lumber trade came the era of steam transport—the steamboat, and a generation later the railway, and in the latter third of the last century the completion of the Union and Central Pacific Railways fired the imagination of the Canadians and led to the building of the Canadian Pacific and the confederation of the several provinces. Incidentally came the opening up of the western prairies to agriculture and the development of land hunger. The Laurentians not only became neglected and partially forgotten in the rush to the West but were regarded as a hindrance to the growth of the railways and even received the title of the "Great Barrier" because railway construction was somewhat more expensive in the region of rocks and lakes than on the grassy plains.

One of the older provinces more conservative and home loving than the others was content to go on developing the lands nearer home and with a somewhat slower and surer expansion, and pushed into the more attractive and fertile portions of the Laurentians, and presently through one source and another it became known that the wilderness of rocks and lakes did not extend indefinitely northwards, and that it was finite and succeeded by a belt of some thousands of square miles of level plains with good soil, and in many ways more desirable for settlement than much of the prairie country itself. The forest still persisted and was deemed more or less of a drawback because the land had to be cleared before it could be cultivated, but to the French Canadian of Quebec, in whose veins still flowed the blood of his pioneer ancestors and who was stirred by the same instincts, this was not an unmixed drawback. He had compensating advantages. When the long winter came on and the northerly gales blew he had shelter in his forest home and abundance of firewood. The house itself was built of logs, roughhewn, but it was all the warmer for that. The narrow trail through the forest to the nearest neighbor or settlement was always open and easy to travel even during a snowstorm, while the prairie settler might be locked in for days at a time and able to go a few yards from his door only at the risk of his life. The forester could always make a little, sometimes a very good income, trapping the fur bearing animals and occasionally bringing home a supply of fresh meat. The prairie dweller could do nothing but feed his stock, if any, and then read and brood.

The forest persisted to the north but the pine gave

way to spruce. This seemed like a drawback a generation ago, for the French Canadian settler often depended on work in the lumber camps for the winter, and as this industry waned and its centers got further away he was obliged to leave his wife and young family to look after themselves for months at a time. More recently spruce, even small spruce, has come to its own and is in itself an important natural product in the making of pulp and paper. Northern Quebec is essentially a spruce country and the great danger is that the spruce will be cleared off too soon and the prairie conditions established before the settler can become self-supporting on agriculture alone.

The north country is developing other resources. Gold mining has become a recognized industry of the south edge of the clay belt in Northern Ontario and the same industry bids fair to spread far to the eastward where other minerals have also been found. Except lignites and coals, which have as yet, owing to their great distance from industrial centers, only a limited local market to depend on, the prairie provinces have no such mining prospects. Their output is wheat and other grains, and while these are unsurpassed in quality and bid fair to lead the world in quantity the market is a long way off and the competition with the output of the Argentine for instance, inferior in quality, but better situated economically, is keen.



RAILWAY RECONNAISSANCE IN WESTERN QUEBEC—THE OLD AND THE NEW

A generation ago some enterprising men, notably H. J. Beemer, with far less knowledge of the northern country than we now possess were, undisturbed by the glamour of the west, steadily engaged in pushing the railway system northward into the Laurentian wilderness to provide for and encourage settlement and development. The Quebec & Lake St. John was one of the first railways, and belonging to the same era were the Montreal & Western, and the Gatineau Valley. After some years of struggle the Quebec & Lake St. John met with the new development of the pulp industry and became an important and busy line, an important feeder to the Canadian Northern and its successor the Canadian National. More recently it has been an essential factor in the great power development on the Saguenay, rivaling Niagara in magnitude. The other two lines mentioned fell into the hands of the Canadian Pacific, and also became useful not only as feeders but as developers. Both extended into a pine country and it was thought that when the pine was exhausted their usefulness was gone, but not only have the spruce and hardwood taken its place but both lines have developed a remarkable suburban business from their parent terminals, Montreal and Ottawa.

This is not only a summer business but lasts all the year round. The Laurentian country with its brilliant sunshine, dry clear air and beautiful scenery is as attractive and healthful in winter as in summer, and the pursuit of health and the treatment of pulmonary complaints has attracted nearly as much travel as have the fish and game and winter and summer sports.

The feverish rush to the west continued and led to the building of a third transcontinental line, the Grand Trunk Pacific, and to make the latter more attractive to the French Canadian voter the eastern extension of this was carried far to the north of Montreal and Ottawa. As a transcontinental carrier it was a redundancy and far ahead of its time, but it did open up and advertise the eastern end of the clay belt, and colonization commenced almost at once. At the present day there are some tens of thousands of settlers along the line in the Province of Quebec alone, and these, almost to a man, of native stock. This agricultural population has for its business center the town of Amos on the Harricanaw River on the northern side of the divide between the St. Lawrence and Hudson Bay.

If we look at the map we shall see that the two branches of the Canadian Pacific are already nearly half way across the Laurentian tract between the Transcontinental line and the older railway system to the south, and that the longer of the two is almost on a direct line between Montreal and Amos. The other, originating in Ottawa, has already pushed north to within 40 miles of this direct line and that the production of these two to a common point and thence to Amos would give a much desired and shorter outlet to Montreal, Ottawa and incidentally to Toronto, New York, and the financial and industrial centers of the continent generally. The same applies to the rapidly developing mineral belt to the south of Amos in a still greater degree, and still further south and east is the last considerable belt of white pine forest still untouched by the lumberman. The reason it is untouched is that the only way to get it out is by floating down the Ottawa some hundreds of miles, a proceeding involving much expense and loss of time and money, for the rivers of this region and more especially the Ottawa are not like rivers in other countries and other parts of this country, but are rather a succession of lakes with short connecting waterways sometimes only a few yards in length. The railway is the only known means of economical transportation.

The Laurentian as mentioned above is noted for its thousands of lakes, but this particular basin of the Upper Ottawa is perhaps the most notable section of all

in this respect with its hundreds of lakes and ponds. Incidentally this is one of the most remarkable fish and game preserves of Quebec and a paradise for the sportsman tourist and camper—400 ft. higher than Muskoka, much greater in area and still a virgin wilderness and within two hundred miles of Montreal.

This is a somewhat long story but most of it necessary for a proper understanding of the project, the Abitibi Southern Ry., conceived by a gentleman of lifelong experience in building development lines in the province. It is notable that in the reconnaissance carried on during the late summer great use has been made of a hydroplane. The multitude of lake expansions renders this method most appropriate, and the Quebec Streams Commission has adopted it in its researches into the possibilities for storage and regulation of water in this same territory.

It has fallen to the lot of the writer to supervise this reconnaissance, and it is an understatement to say that the work has been interesting to one who has spent a good deal of his life on similar work but with very much older and more primitive means of travel. Instead of the canoe toiling along at the rate of three to four miles per hour by sheer muscular power the explorer is carried luxuriously along at twenty times that rate and without exertion, and instead of having his view limited to a few hundred yards on a river or to a dozen miles at most on some of the larger lakes, his horizon is often 60 or 70 miles away, and he can overlook some hundreds of square miles at once. If a horizontal projection, a map of the country, were his only object and the lakes and water courses and great mountain ranges the only obstacles he has to locate and circumvent, a few flights in a hydroplane would give him in a dozen hours as much information as he would acquire in several months of travel by the older

AMOS, QUEBEC, THE NORTHERN TERMINAL OF THE NEW LINE

methods and in some particulars more; but there is another point of view, more than one other in fact, and the principal of these and often the most important of all is the determination of elevation of hills and ridges and the lowest gaps and passes through them, and another of lesser moment is the determination of the character of the surface geology and the materials of which his cuts and fills will be composed.

In conjunction with the older methods of canoe traveling we used to find high bold rocks with bare summits approaching our watery routes from time to time and, landing for an hour or two, we could climb these and get a fairly extensive view, but even looking from these comparatively low elevations we found that we had to be cautious in our conclusions, for the minor elevations, especially in the near foreground, were apt to be greatly flattened out and dwarfed, and it was only near the horizon that we could make at all reliable

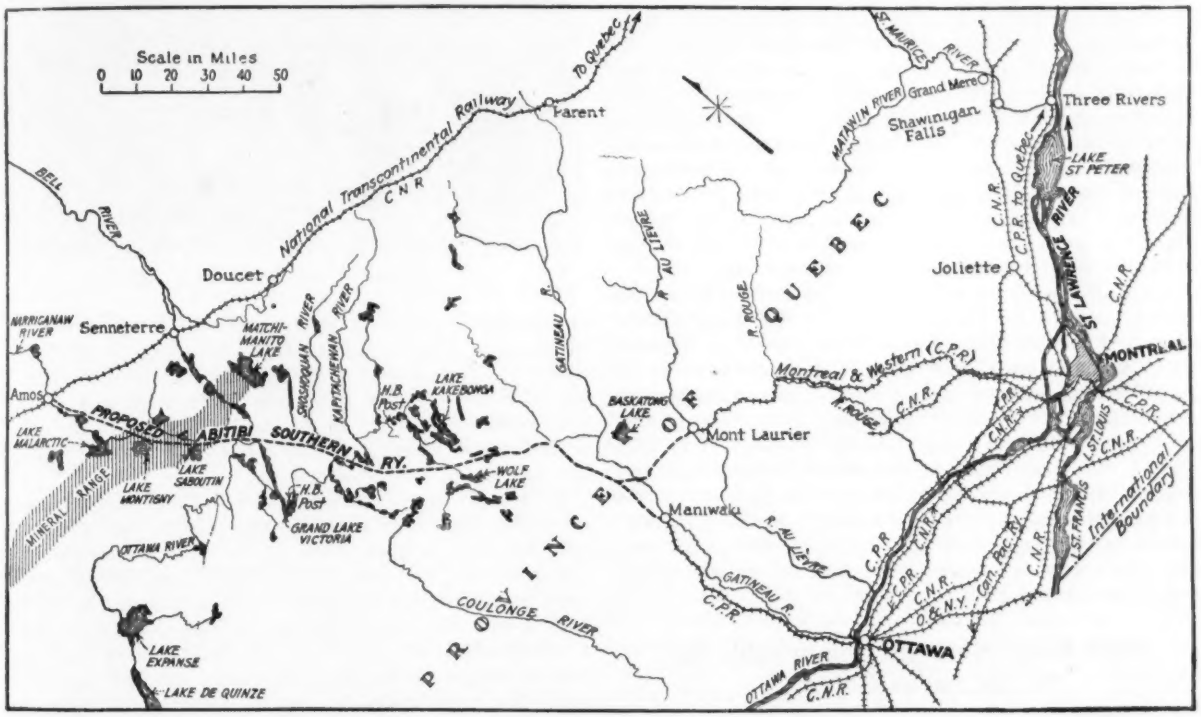
CHARACTERISTIC SECTION OF UPPER OTTAWA RIVER

estimates of relative elevations and depressions. In the case of the airplane the much greater elevations imposed by safety considerations accentuated this difficulty tremendously.

My predecessor on the main flight pronounced the country as level throughout. More recent examination showed it for some 60 miles or more to be a series of knobs and ridges, sometimes 100 ft. or more in height. Not so serious a matter on the whole because these ridges were seldom continuous for great distances, but the conditions were formidable enough to show that considerable curvature would be necessary if nothing more, and that lakes and their arms and bays were not the only matters to be studied and circumvented. Some of the most satisfactory ocular observations were made on a flight over a continuous waterway several tens of miles in length where it was safe to fly within 50 ft. of the water level and get views similar to those obtainable from a canoe on the larger lakes where there was a definite horizon to be referred to, which I have always found the most valuable and reliable.

The difficulty with the plane in this case was that the speed was necessarily so high that the views were only glimpses too fleeting to be photographed on the brain with any precision. This difficulty could of course be overcome by the use of the camera, and as a matter of fact some of the most instructive views I have are those taken obliquely, and for a preliminary study I should, if I am ever again called on for a similar piece of work, confine it almost exclusively to "obliques," leaving the verticals to serve as amplification of detail after a definite route had been decided on. For such an amplification the vertical photos are superexcellent, every house and outbuilding, every bed of a river or stream, every bay and island in the lakes is shown with a truly wonderful precision and even the species of timber and surface growth can be determined by an expert with considerable precision, and it is notable that the camera records all this information at no more cost of labor or apparatus than when the surface picture is seven-eighths water and the other one-eighth bare rock.

My very good friend, Ellwood Wilson, the representative of the aerial survey company doing our work, and an enthusiast in his exposition of the possibilities of the new method, points out that by reversing the process of perspective drawing, by working from the picture backwards to the horizontal projection instead of forwards from known distances to the picture, the oblique photograph can be got to supply all the data for a very fairly accurate map. I do not doubt this for a moment and quite recognize the principles involved, but this means a lot of time and detail work in an office perhaps some hundreds of miles away, and when this is done—*cui bono*. It is quite a wonderful achievement, but as an ordinary reconnaissance party and at best the airplane is dependent for a knowledge of its own elevation on the aneroid barometer. Most engineers, the writer included, are somewhat suspicious of unchecked statements made by this very beautiful and useful instrument which can be terribly out at times while showing always an open and unblushing face to the observer. In any case this is an argument for reliance on a multiplication of oblique views and not for verticals, and also for as low a flight as safety will permit. The views then obtained will approximate those obtained from a bare rocky hill standing slightly higher than its fellows, but still to my mind inferior to those from a



WESTERN QUEBEC, SHOWING PROPOSED RAILWAY

some distinguished officer remarked of a famous charge —"*C'est magnifique mais ce n'est pas la guerre.*" To the railway reconnaissance man the scientific triumph is magnificent but it does not aid him appreciably in his work. The photograph itself shows him practically as much. What he wants is a *relief* map of a narrow strip of country which will furnish him with a practicable line. The vertical angles are to him far move important than the horizontal. A slight curve or revision of the bearing of a tangent will get him past a bay or a lake, but a very few minutes of vertical angle will change a summit from one easily surmountable to an absolute impossibility and condemn a projected route for miles in either direction.

My friend then brings in to me a very learned treatise proving that from a combination of two or more oblique photographs the elevation of any point in sight from both of them can be fixed, and a regular system of contours can be established. Perhaps so, but in a forested country these would necessarily be those of the tops of trees. The process as explained is complicated and involves much calculation and office work, and seems to be much too cumbersome and slow for canoe on a big lake with an unimpeachable horizon to refer to, and always the canoe can stop for a few minutes' study while the plane must keep moving along.

No doubt as aeronauts come better to understand the reconnaissance engineers' requirements and the latter more accustomed to "snapshot" observations the airplane will come into more extended use, but at the present time I think the combination of the old and new methods suggested in the above will be found best and most reliable. It must be remembered that even the most enthusiastic of aeronauts does not claim that the hydroplane can be taught to cut down trees or drive stakes or run in curves on the ground. A field party is necessary in any case and with a comfortable camp as a base, a couple of extra men will bring in an immense amount of information about the country ahead and bring it in as fast as required. The speed of a location party is largely regulated by that of the axeman in clearing the line of sight for transit and level and the ability of the transit man to keep them fully occupied.

While the writer has been at some pains to explain at length what in his judgment and experience are the shortcomings and weaknesses of the new system of

surveying as applied to railway work, he does not by any means wish to be understood as belittling its value as an aid and complement to the older methods. One flight of two hours showed him as much as could have been obtained in 8 to 10 days' travel by canoe and on foot and at less cost and physical exertion. Another flight of four hours showed more of the natural resources than could have been seen in as many months. He believes that a properly designed airplane will in the near future come to be considered as an essential part of the equipment of an exploration expedition in an undeveloped country, and that it is also invaluable in connection with photography in the completion and amplification of detailed and precise surveys.

I have been asked how the photographic surveys were brought to proper scale in an unsurveyed country. As a matter of fact on a preliminary survey such as was undertaken the exact scale was a matter of minor importance. But it so happened that at both terminals we had fairly reliable surveys to compare with ours. Maniwaki, Mont Laurier, and Amos and its surroundings all had official plans to show, not very precise but sufficient for our needs, and midway one of the larger lakes had been much more accurately traversed by the engineers of the Quebec Streams Commission.

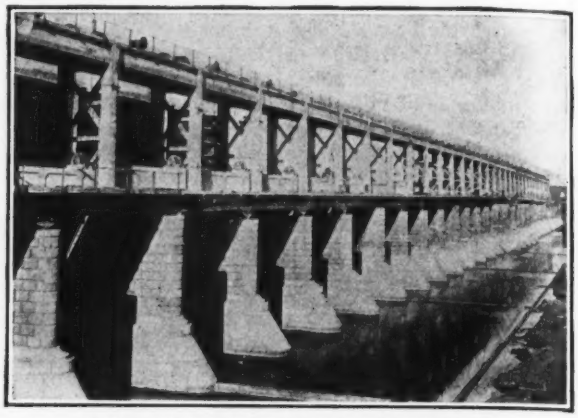
In conclusion it is a great pleasure to testify to the interest shown by every member of the staff of the Fairchild Aerial Survey Co., which had the contract for flying and aerial surveying. The question was always, "What can we do to make the work complete and satisfactory?"—Not "how much is it going to cost us beyond what we figured on?" The desire to help was, I think, mutual and reciprocal between the two parties to the contract, but the best of good will could not furnish continuous good weather, and the past summer was perhaps unusually marked by cloud and rain for a territory such as the Laurentian which has a good reputation in this respect.

Vaal River Barrage Remarkable for Its Large Gates

A MODEL of one of the gates of the Vaal River barrage, displayed at the British Empire Exhibition, has renewed interest in that great structure which was built by the Rand Water Board during the years 1916 to 1922 to supply water for the Rand gold mining area in South Africa. A description of the structure was given in *The Engineer*, London, Dec. 1, 1922. The following particulars are given as a matter of record:

The barrage is built across the Vaal River 25 miles south of the town of Vereeniging to form a reservoir 40 miles long with a capacity of over 16.3 billion gallons. After allowing for losses from evaporation and seepage and the 2.2 billion gallons reserve for agricultural purposes on the reservoir area, there is still available 24 m.g.d. for use of the gold mining area.

Like the majority of South African rivers, the Vaal has a great variation in the flow according to season and carries down with it enormous quantities of silt. The flow varies from nothing to 187,000 sec.-ft. and the yearly amount of silt carried through the barrage is estimated at 1,200,000 tons. For this reason a type of structure, consisting entirely of sluiceways with their sills at the level of the river bottom and of such length that the total water area would be greater than the corresponding cross-section of the river, was adopted. In order to compensate for the area occupied by the piers, the river channel at the site of the barrage was widened from 620 ft. to 1,400 ft., giving a total clear width of channel 40 per cent greater than the normal width. The whole structure is built on rock, the foundations and piers being of mass concrete and the



VAAL RIVER BARRAGE, SOUTH AFRICA

superstructure of reinforced concrete. The piers are 35 in number, each being 34 ft. 6 in. high, 55 ft. long, and 8 ft. thick, forming 36 openings between the piers 30 ft. wide. The 36 gates are 25 ft. high and 32 ft. 6 in. wide and are let into slots 18 in. deep in the side of the pier in which are located the vertical roller trains against which the gates operate.

Each gate weighs 26 tons and is balanced by a 60-ton counterweight traveling through half the distance traveled by the gate. The gates and counterweights are connected by two $1\frac{7}{16}$-in. flexible galvanized wire rope passing around a double conical grooved drum in such a way that when the gate is closed the gate rope is attached to the small diameter of the cone and the counterweight to the large diameter. By this arrangement the counterweight exerts its greatest force in starting the gate from its seat, and as the gate raises the relation of the rope is reversed so that there is a braking effect which brings the gate to rest. The whole operation takes about $1\frac{1}{2}$ min.

Incomes from Construction and Transportation

Of the 1,134 companies engaged in the construction of buildings and structures above ground making income tax returns in 1922, 316 paid cash dividends aggregating $4,055,144 and had surplus and undivided profits at the close of the year of $20,104,140. The net taxable income of all companies making returns was $18,117,842. The 1,984 concerns engaged in shipbuilding, railroad construction, dam construction, and other construction activities had net taxable incomes totalling $51,478,950. Of that number 496 companies paid cash dividends of $20,213,581. At the end of the year 1,174 companies had surplus and undivided profits of $129,678,802. These figures have just been compiled by the Bureau of Internal Revenue. They show that the steam railroads had a total net taxable income in 1922 of $255,073,876. The figure for the electrical railroads was $25,570,140; for other rail transportation $53,556,903; for water transportation $31,811,303.

Fatigue Tests of Metals and the Theory of Elasticity

Endurance Tests on Bars With Holes Indicate That Local High Stresses Are Relieved by Adjoining Metal

By H. F. Moore

Research Professor of Engineering Materials, University of Illinois, Urbana

PROBABLY the greatest single step in transforming mechanics of materials from an art to a science—a transformation which is not yet completed—was the development of a method of mathematical analysis and of formulas for the stresses and strains set up in structural and machine parts under given systems of loading. In general, the body of mathematical reasoning concerning mechanics of materials may be divided into two systems: (1) The system commonly used in engineering text-books, frequently called the Rankine theory, which deals directly with external forces and moments as balanced by internal forces and moments, and considers only the common important stresses in machine and structural parts, neglecting the effect of lateral strains accompanying these stresses; (2) a much more elaborate mathematical treatment frequently called the St. Venant theory, which concerns itself not only with the balance of forces, but also with the minute changes of form (strains) set up by these forces. The latter is capable of use with much more complex systems of forces than is the Rankine system. One limit to its application is set by the methods available for solution of differential equations.

In practice both these systems have proved of very great value indeed. The structural engineer and the machine designer would find their work almost, if not quite, impossible without them. No other systems of analysis have been proposed to supplant them. However, it may be profitable to examine some of the fundamental postulates upon which both of these systems rest.

Postulates—Three of these are homogeneity of the material, isotropy of the material (equal stiffness in all directions), and Hooke's law (stress proportional to strain). Theories of elasticity for non-homogeneous and non-isotropic materials have been proposed, but have not come into any general use. Of the three postulates, the first and the second are obviously not true for available structural materials. The non-homogeneous nature of such material as concrete can be seen with the naked eye; the microscope shows the most refined metals to be made up of diverse kinds of crystalline grains; the varying stiffness of such material as wood in various directions is a matter of common observation. As regards the third postulate, Hooke's Law, it is an approximation for most non-metallic materials—and for a good many of them a rather rough approximation. It is quite possible that even for metals it is to be regarded not as an exact law but rather as a very close approximation. A very interesting discussion of Hooke's law may be found in the article entitled "A Generalized form of Hooke's Law," by E. R. Hedrick, in *Engineering News*, Sept. 16, 1915, p. 542.

Why is it that a theory which numbers among its postulates two which are false and one which is approximate has proven so reliable a guide for practice? One answer to this question is that the theories of elasticity enumerated above yield results which are "statistically" true for the more important stresses in structural members and machine parts.

Statistical Aspect of the Theory—Just as it is possible to use mortuary statistics to predict the general death rate of a community, it is possible to use the ordinary theories of elasticity to predict the behavior under stress of a rather small *group* of crystalline grains or of fibers. For example, in applying the common flexure formula to determine the maximum fiber stress in an I-beam under a vertical load, the I-beam is imagined as divided into thin horizontal layers and the average stress in the outer layers is what is determined by the formula. Just as it is impossible to use mortuary statistics to predict the death of individuals, so it would be impossible to use the theories of elasticity to predict the failure under stress of a single crystalline grain, a single fiber, or a single piece of aggregate in concrete. It is not at all likely that the mathematical theory of elasticity with its assumption of homogenous material could be used to predict with accuracy the stress or the strain at the bottom of a prick-punch mark on a steel plate, even if the complex differential equations involved could be solved.

In general, this statistical correctness is entirely satisfactory for determining the significant stresses in structural parts under dead-load, and for determining many of the important stresses in machine parts. In this connection it may be noted that the significant stresses in ductile materials can be predicted with a higher degree of accuracy than can the significant stresses in brittle material. It is doubtful whether this statistical correctness would be satisfactory for determining localized stress around rivet holes, at the bottom of screw threads, and at other places where the maximum stress affects only minute volumes of material. The customary tacit assumption is that such localized stresses are not important under static load, especially for structural parts made of ductile materials. For example, a localized overstress around a rivet hole in the shell of a water tank produces no noticeable general distortion in the tank, nor does it interfere with its function as a structure.

It is usually assumed that the object of the formulas of the mechanics of materials is to determine the strain in the "most stressed fiber" of a structural or machine part. It would probably be more accurate to say that a formula is used to determine the maximum stress which affects a considerable volume of metal. Under impact loading, it has been recognized, localized stress is of more importance than under static loading and it is evident that under repeated or "fatigue" loading localized stress which is negligible under "dead" loading may be very important indeed, on account of the danger of starting a spreading "fatigue" crack.

Local High Stress and Fatigue—Recent repeated-stress or "fatigue" tests have been made in England and in the United States, on flat plate specimens with small holes in them. The effect of this small hole according to the mathematical theory of elasticity is to increase the localized stress around the hole to about three times the value of the stress in a similar specimen without a hole. The tests under repeated load were made to determine whether the "fatigue" strength of the plate with a hole would be lowered to one-third the value of the strength of the plate without the hole.

The test results showed that for no material tested was the reduction of strength as great as that called for by the mathematical theory of elasticity. This was true even under completely reversed stress, with computed stresses below the elastic limit of the material. Apparently values given by the mathematical theory of elasticity over-emphasize the effect of this highly localized stress.

Influence of Adjacent Metal—One explantion of this over-emphasis lies in the fact that the mathematical theory of elasticity makes no distinction between a "fiber" stressed to a given amount with many understressed fibers nearby on which, so to speak, the stressed fiber can call for help in carrying its load, and a fiber surrounded by other fibers stressed almost as highly as itself, which, so to speak, cannot hope for any great amount of help from these heavily loaded fibers. It has been recognized for some time that under static loading the tendency to damage by a stress depends not only on the magnitude of the stress but also on the proportion of cross-section affected by that stress and on the proximity of areas of understressed material.

If two test beams be made from the same piece of steel, one an I-beam and the other a round rod, and the yield point be determined by a flexure test, the value found for the round rod will be far in excess of that found for the I-beam. This tendency towards reinforcement of strength by understressed portions of a structural part is recognized in the building ordinances of cities, which commonly allow a unit-stress of 16,000 lb. per sq.in. on the outer "fibers" of steel I-beams, and a unit-stress of 25,000 lb. per sq.in. on the outer "fibers" of steel pins. The results of the recent fatigue tests on specimens with holes would seem to indicate that the reinforcing action of understressed fibers is effective even under the action of repeated loading, though not so effective as it is under static load.

Equalization of Stress—Another explanation of the above test results is that the maximum stresses and strains between adjacent crystalline grains of metal, between adjacent fibers of wood and between pieces of aggregate in concrete are greater than the "statistical" stresses and strains given by the mathematical theory of elasticity, and that under loads well below any recognizable "elastic limit" there are minute inelastic slippages between adjacent particles (for example between thin laminae within a crystalline grain of metal), and these slippages tend to reduce localized overstress. This explanation is supplementary to the first explanation given, rather than contradictory to it.

Effect of "Stress Raisers"—A third explanation recognizes that in specimens without holes, nicks, or deep scratches there are many features of internal structure which like the drilled hole act as "stress raisers." The comparison of fatigue strength between specimens with drilled holes and specimens without holes is a comparison not between really homogeneous material and homogeneous material as affected by the introduction of a definite source of stress irregularity, but between metal with many stress irregularities already in it and the same metal with the addition of yet another irregularity caused by the drilled hole. The weakening effect of the drilled hole is somewhat greater than that of the inhomogeneities present (such as weak crystalline grains, inclusions, minute flaws in the metal) and the specimen with a hole is weaker than the specimen of the same net cross-section without a hole, but the hole acts as a stress raiser not in ideal material such as is postulated by the theory of elasticity, but in metal with its ideal strength already diminished by internal imperfections. This third explanation is also to be regarded as supplementary to the two others and not considered as contradictory to either.

Both static tests and repeated-stress tests show that localized stress is more dangerous in a brittle material than in a ductile material. This gives a hint of the significance of ductility in materials of construction, namely the ability which ductility of material confers on a structural or machine part to withstand localized overstress without serious structural damage to the part as a whole.

From these fatigue experiments on specimens with holes, and from all other experiments with which the writer is familiar, it seems that the application of the mathematical theory of elasticity, either in its simple Rankine form or in its more elaborate St. Venant form, yields results which are on the *safe side*, that is, the theory of elasticity predicts a degree of damage (as measured by a stress or a strain) more serious than the degree of damage sustained under actual working conditions. Doubtless, this fact is one explanation of the reliability for the engineer of the formulas of the mechanics of materials.

The structural engineer and the machine designer should not regard the mathematical theory of elasticity as an absolutely exact statement of physical facts simply because it uses precise mathematical methods. The mathematical theory of elasticity may be regarded as an idealized diagrammatic representation—perhaps we might even say a cartoon—of the state of stress and strain which exists in stressed members. The picture presented is not accurate in all its details but it conveys the general information necessary for the safe design of nearly all structural and machine parts.

South African Hailstorm Wrecks Tiled Roof

Of 15,000 tiles on the roof of a school at Wonderbloom, near Pretoria, South Africa, only 800 escaped damage in a hailstorm which visited the Pretoria area Christmas Day, 1923, says a recent issue of the *South African Irrigation Magazine*. According to an official of the South African Meteorological Office, one of the hailstones which was recovered measured 4 in. x 3½ in. x 2 in., and weighed 5.1 oz., and eight other hailstones weighed almost 2 lb., or an average of 4 oz. each. The weight was obtained by melting and measuring in a cubic centimeter measure glass. The damage done by this 10-min. hailstorm and its subsequent rain was in the neighborhood of a half a million dollars. Though the storm was unusual in its intensity and the hailstones were almost unbelievably large, not a single life was lost. Besides the complete wrecking of a heavy tiled school roof, other indications of the size of the hailstones can be had from the fact that the horn of a cow was struck by a hailstorm and broken off at the root and 22-gage corrugated sheets were pierced. Hailstones also passed through a ¼-in. plate glass reinforced with 1-in. mesh wire netting in the roof of the studio of the South African Criminal Bureau.

Operation of Ohio Sewer District Law Since Enacted in 1911

Used in 18 of 88 Counties of State Which Have Already Spent More Than $20,000,000 for Water and Sewerage

By R. F. MacDowell
County Sanitary Engineer, Cuyahoga County, Cleveland, Ohio

OHIO has in operation a county sewer district law which grew out of a demand for sewerage and water-supply improvements in rapidly growing unincorporated communities adjacent to the larger cities of the state, as well as in the summer resort communities located along the shores of Lake Erie and the several inland lakes. The law makes possible the construction of sewer and water improvements on a comprehensive scale to serve natural drainage areas rather than individual political subdivisions, and places the organization and supervision of the work under the board of county commissioners.

There are 88 counties in Ohio, of which 18 have already made use of the law, and of these 6 counties have formed 53 districts, comprising a total of some 177,000 acres. About $19,000,000 has been spent for water and sewer improvements in the districts of these six counties alone. The total expenditure under the law must be considerably over $20,000,000, with much more in prospect.

The Ohio Law—The County Sewer District Law (Sec. 6602-1 to 6602-33, General Code of Ohio) was first passed in 1911, to meet the needs for the proper and economical development of sewerage for several fast growing but unincorporated communities in Lucas County, adjacent to the city of Toledo. The law was amended in 1913, 1917, 1919, and 1923, by adding sections which experience with its operation had from time to time proven necessary or desirable. The law of 1911 and that of 1913 did not give authority for the construction of water mains as county sewer district improvements, but the advantages of the law soon led to an attempt to broaden its scope to include water supply facilities and these provisions, closely paralleling the sewerage sections, were added in 1917.

Briefly, the law authorizes boards of county commissioners to create and maintain one or more sewer districts within their respective counties, for the purpose of promoting the public health and welfare, such action being upon their own volition, but usually only after popular demand by the property owners of the territory affected. Such districts may consist solely of unincorporated territory or, upon authority given by the council of any municipality, may be made to include the whole or a part of the territory of such municipality. After the establishment of any district, the county commissioners may appoint a competent sanitary engineer, with necessary assistants and equipment and, in a county having over 100,000 population, may create a sanitary engineering department. It is the duty of the sanitary engineer to direct the work within the sewer districts, subject to the approval of the county commissioners, preparing general and detail plans, specifications and estimates, supervising all construction work, computing assessments and maintaining the improvements after construction.

Financing—The improvements are *in general* financed by special assessment county bonds, with the credit of all of the taxable property of the county back of them but with the entire cost assessed upon the property within any sewer district which is especially benefited, in direct proportion to such benefits. The assessments for any improvement are not levied upon the benefited property until after the construction of that improvement is completed and the actual cost known—differing in this respect from municipal practice in Ohio. The bond issue is made large enough to cover the payments of principal and interest upon the bonds until the first levy of special assessments becomes due. The bonds are serial, and must be entirely retired within 20 years after their issuance. The preliminary engineering and other expenses for any improvement may be met either by appropriation from the general funds of the county, by the issuance of general county bonds, or by the sale of certificates payable in not over five years from the proceeds from the sale of bonds for specific improvements. Also, the cost of the improvements themselves may be met by certificates of indebtedness issued from time to time during the construction work, as money is needed to pay contractor's estimates, these certificates being redeemed by the sale of special assessment bonds after the construction work is completed. This provision saves much money as by it interest is paid upon the cost of an improvement only as the money is needed. The cost of maintenance of completed improvements is financed by special assessments, except that the cost of maintenance for the first year is included in the original bond issue.

Assessments—The assessing authority under the sewer district law has much latitude in securing an equitable apportionment of the cost of the improvements upon the property benefited. The law provides that any part of the cost of the construction or maintenance of any improvement may be paid by the county at large, at the discretion of the county commissioners. It is considered a wise financial policy, in most counties of Ohio, however, to assess all the cost upon the benefited property. In computing assessments the law provides that property immediately abutting upon any sewer or water main shall be first assessed for local benefit, or the equivalent cost of a local sewer or water main, the excess, if any, to be met by an assessment upon all of the property within the district, including the abutting property, which is benefited, in proportion to and in accordance with the special benefits conferred. There is no limit to the assessment which may be imposed under the law except this one of benefit. With this method, as nearly as possible ideal and equitable justice can be obtained, the theory being that all property shall be assessed alike for like benefits. It is left with the county commissioners, through their sanitary engineer, to grade or zone the assessments for each improvement so as to allow for the elements of deferred or potential benefits, valuation, topography, shape or usefulness of property and other features which control equitable assessment.

Extent of Operations in Ohio—Lucas County initiated the sewer district law and was the first county to use it, starting operations soon after the law was adopted in 1911. In this county 11 sewer districts have been created to date, covering a total area of about 50,000

acres, and about $7,000,000 has been expended for sewer and water supply improvements. For the whole state 18 of the 88 counties have created one or more sewer districts. These include all but one of the eight counties along the shores of Lake Erie, where the districts are divided between summer resort colonies and suburban communities adjacent to the large cities, including Cincinnati, Dayton, Columbus, Toledo, Akron, Sandusky, Youngstown, Warren, Painesville, Canton, Lima and Ashtabula, besides which the one or two inland counties having small lake summer resorts have established sewer districts.

In Cuyahoga County, the most populous county of the state, with more than a million people (including the population of Cleveland) the sewer district law was not used until 1920, when the first districts were created and the first preliminary engineering work done. Since the fall of 1921, when the first contracts were awarded in this county, a total of 106 miles of sewers and 116 miles of water mains, besides three pumping stations, a concrete water storage reservoir and two sewage-works have been constructed in the seven sewer districts created, with a total expenditure of approximately $6,500,000. These sewer districts cover in the aggregate about 46,000 acres and are located in all parts of the county. There are, besides Cleveland, 3 cities and 32 incorporated villages in Cuyahoga County and many of the villages are taking advantage of the sewer district law by authorizing the county commissioners to include their areas in sewer districts for the purpose of constructing the main works for sewerage or water-supply improvements, especially where such main works are the most logical developments, from an engineering and economic standpoint, to serve the areas of more than one municipality within the county.

In Franklin County, around Columbus, the 12 sewer districts established to date cover about 42,000 acres, and about $1,100,000 has been expended for water and sewer improvements since 1919. In Summit County, around Akron, the 9 districts comprise 20,000 acres, including two municipalities, and $862,000 has been expended, while in Montgomery County, around Dayton, $3,000,000 has been spent in 9 districts covering 6,870 acres. Mahoning County, near Youngstown, has 5 districts covering 12,000 acres, and has constructed water and sewer improvements costing $1,200,000. In addition to these counties, districts have been created and considerable work done in Lake, Ashtabula, Erie and Trumbull Counties, while some work has been started in seven other counties.

The number of plans which the county sanitary engineers have submitted to the State Department of Health for approval within the past two or three years has reached a total which demands a considerable part of the work of reviewing plans by the engineering division of the department. The division strongly endorses the sewer district work, and encourages the creation of new districts in all parts of the state. It has also sponsored a semi-annual conference, by all of the county sanitary engineers of the state, with the engineering division of the state board, for the purpose of exchanging views regarding the work and standardizing the practice in the several counties. These conferences have been of decided value to the engineers and to the service given in the sewer districts which they represent.

Common Losses in Road Grading With Fresnos

Short Loading, Poor Plowing and Grubbing, Erratic Performance, Wet Weather — All Can Be Remedied by Careful Management

By J. L. Harrison
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IN MOVING earth by fresno, the typical operations are: (a) Loading, (b) hauling to the dump, (c) dumping and spreading, (d) returning for the next load, and (e) turning to load again. The order of these operations may be varied, but the sequence is of less importance than the nature of the operations themselves because, whatever the sequence, each takes time and is, therefore, a source of possible loss.

One of the most significant is short loading. It takes just as long to move half a load as it does to move a whole load. Therefore, if a proper output is to be obtained, the loading must be kept up to standard. The bureau's studies indicate that a standard 4-ft. fresno loads about ½ cu.yd. per trip. On a well-managed job the fresnos will be loaded to their standard capacity every trip. A part of the load may be dropped during a long haul, but, from the standpoint of the practical contractor, the effect of this is relatively small, because he can easily allow for it by leaving the grade a little low if much hauling is to be done over it. In any event he generally finds it necessary to go back over his work and correct it for shrinkage, etc., when the final stakes are set; and the material that falls off the fresnos usually serves to reduce by so much the amount that must be handled in the clean-up. Short loading, however, is a positive loss the causes of which should be sought and eliminated wherever possible. It may be due to the indifference or inefficiency of the drivers. When this is the case the drivers should be trained to load properly or they should be instantly replaced.

Poor plowing is often an element in short loading. It also affects the time spent in loading. If the soil is properly plowed, a full load can be secured in sand unless it is very dry, in loam, and in clay except where it is unusually heavy. But plowing is relatively expensive and is hard on the stock—particularly plowing in that sort of heavy ground where it is most needed if full loads are to be taken without undue loss of time. In such cases the problem presented to the foreman is a choice between the tangible reduction in output which will result if a fresno is laid off and the mules are hitched to the plow, and the intangible losses which result from slower and lighter loading when there is inadequate plowing.

Light loading and loss of time in loading sometimes result also from failure to remove the roots and trees. If the contract price for earth excavation is 20c. per cubic yard and labor is 25c. an hour, an increase in output of 12½ cu.yd. will pay for a 10-hour day's work in removing roots. With an ordinary small outfit of six to eight fresnos working on a 100-ft. drag, the loss of as little as 0.05 minute per load or of 2 per cent in the amount loaded is sufficient to justify the employment of an extra laborer to remove roots or obstructions of any other character which interfere with proper loading. The losses due to obstructions are often much greater than this.

On short hauls every effort should be made to secure heavy loading. Whatever additional yardage may be secured in this way is a clear gain. It is not advisable, however, to attempt heavy loading on long hauls, because of the greater amount of work such hauls impose on the stock. In a haul of 100 ft., the round trip time averages 2.2 minutes. Twenty-seven trips are made in an hour. Only one-half minute of the trip time is spent in hauling the load to the dump, which means that the team is under full load 12½ minutes per hour. On a 300-ft. haul the time required per trip is 4.2 minutes, and there are 14 loads per hour. In this case the team is under full load 1½ minutes per trip or 21 minutes per hour. The fact that on the longer haul the stock performs 50 per cent more heavy work during the day than on the short haul offers a reasonable explanation of the fact that—even without extra-heavy loading—stock generally shows a distinct loss of weight if held on long-haul work for a protracted period.

Consistency of Performance Important—One of the more conspicuous facts brought out by the studies is that the difference between good management and average or poor management is largely a matter of the consistency of the performance. Good management sets a high standard and consistently follows it. Under average or poor management the results secured will at times compare favorably with what would be expected under the best of management, while at other times the results will fall so low as to be classed as poor.

The lack of consistency can be traced to a tendency on the part of many foremen to allow the physical conditions surrounding the job to govern performance. If these favor a high output, a high output is secured, but if they tend to create losses no adequate effort is made to avoid their effect. So, if the lay of the work suggests that a long swing at the dump be made, the long swing is not prevented by managerial effort, though the loss of but a tenth of a minute on each load may easily mean the loss of a hundred yards on the day's output. The tendency of foremen to allow physical conditions to establish the details of performance which they should themselves govern may in some cases be due to lack of energy, but it is more apt to be a matter of lack of training. However, the point it is desired to emphasize is that a contractor should view inconsistency in output on a fresno job as indicating weak field supervision and take immediate steps either to develop or to displace a foreman whose record of performance is of that kind.

The difference between good and average management as measured by the results obtained may be illustrated by the following example: A normal fresno job will show an average haul of perhaps 150 ft. On such a job the average output under average management would be about 73 cu.yd. per fresno per day of 10 hours. Under good management it would be about 95 cu.yd. per fresno per day. With a 10-fresno outfit the difference in output would be 220 cu.yd. per day, which at 25c. per cubic yard, is $55 per day. In other words, on such a job as this a saving of one-tenth of a minute per load means a saving from $7.50 to $10 a day for the contractor.

So far no significant differences have been found in the rate at which such materials as sand, light gravel, loam, clay, or even heavy clay are moved once the load is taken. There is little variation in the pace of the mules either in moving the material or returning from the dump. There appears to be a little slowing down in loose, dry sand and a little speeding up on material which packs readily and gives a particularly smooth, hard footing, but in the Mississippi Valley, where the bureau's studies have been made, such materials are exceptional. On the other hand, very stiff clay loads with difficulty even when well plowed, and there is a distinct tendency for the men to tire when handling it. Under conditions involving heavy work in loading it is well to put on an extra man to load the fresnoes in order to relieve the teamsters.

Wet Weather Losses Avoidable—It is customary to stop work whenever there is rain and to delay reopening until the ground has dried out more or less. During such delays the stock has, of course, to be fed. Many contractors also feed their men without charge, and it occasionally happens that labor conditions are such that the men also must be paid. It should, therefore, be noted that fresno work can be performed without great difficulty even in mud so deep that the mules sink above their fetlocks. Nor is the work as much delayed by such conditions as might be supposed. The mules move a little more slowly and there is a tendency to lose time in loading and dumping, but outputs can be readily secured which more than cover operating costs. The dead losses of the corral and the mess are thus avoided even though no profit is made. After a heavy shower work should be started at once. The surface of the ground will be muddy but a single cut will remove the mud, and even if the wet earth must be cleared from the path over which the teams move the actual cost of this operation is small as compared with the cost of delay. As soon as the wet surface is removed, a fresno job can be made to run as smoothly as in dry weather.

Another loss that can be easily avoided is the maintenance of extra stock. It is not uncommon to find that an outfit is maintaining 3 to 5 extra animals in the corral as against 25 to 30 on the job. On the other hand, one job (not a fresno job) now under study maintains 44 horses on the job with a reserve of one in the corral. With proper attention to the selection of good drivers and with proper attention to the stock there is small need for more than one extra animal unless the outfit is unusually large. At present, feeding a mule costs from 60 to 70c. a day or about $20 a month. Any animal which has a tendency to "go lame" or injure itself on the work is, therefore, too expensive to keep.

The discussion presented above is abstracted from a paper in *Public Roads*, September, 1924.

Pump Instead of Siphon for Liverpool

In putting in its fourth line of pipe from Lake Thirlmere the city of Manchester, England, is omitting the 14-mile siphon at the lower end of the aqueduct and putting in an electrically-driven booster pump to increase the delivery capacity of the lower portion of the existing pipe lines. The portion of the fourth conduit being constructed, and now almost completed, is described by the London *Engineer* as having an inside diameter of 54 in. and being composed of "about 26 miles of welded steel, 4½ miles of 'Bonna' reinforced concrete, about one mile of concrete-lined cast iron, and the remainder of unlined cast iron."

Winter Hydro-Electric Plant Construction in Minnesota

Barges in Summer and Sledges in Winter Brought in Materials—Temperatures Fell to 50 Deg. Below Zero—Belt Conveyors and Gravity Railway for Concrete

By George H. Herrold
Managing Director and Engineer, City Planning Board, St. Paul, Minn.

WATER transportation and winter construction are interesting features of a new hydro-electric plant on the Kawishiwi River in northern Minnesota. While the installation is not a large one, only two 2,500-kva. units with another 5,000-kva. unit planned, it calls for a dam structure of some magnitude and is so isolated as to add considerably to the construction difficulties. A large camp and plant were in particular called for, there was some very hard excavation in black jasper, and, as stated, there was winter work in a cold climate.

Location and Structures—The Kawishiwi River, flowing from Garden Lake into Fall Lake with a drop of approximately 67 ft., makes a reverse curve similar to a letter S. The development consists of a dam and head-works across the river at approximately the middle of the latter with pipe lines leading from the head-works across the lower neck of land to the power house on Fall Lake. The dam is located above a natural waterfall of about a 30-ft. head, placing the forebay upon a solid rock hill overlooking Fall Lake and some 60 ft. above it. Beginning at the right bank, it consists of the following structures: (1) A puddled earth dike 250 ft. long with a core and reinforced-concrete wall 175 ft. long and 40 ft. high, retaining it; (2) a concrete gravity spillway 175 ft. long and about 50 ft. high with three 20-ft. tainter gates; (3) one 6-ft. log sluice; (4) 150 ft. of concrete non-overflow retaining wall leading up to the right side of the head-works —in this wall are three 15-ft. openings closed with stop logs that can be used for discharging water in an emergency; (5) to the left of the head-works a concrete non-overflow retaining wall 250 ft. long extending to an earth embankment which runs upstream one-half mile.

The concrete head-works contain trash racks and head gates. From the head-works down over the hill a distance of 235 ft. are two 9-ft. wood-stave pipe lines. Provision has been made at the head-works for installing in the future another pipe line of 12-ft. diameter. Also the two 9-ft. pipes are so constructed that they can be replaced by 12-ft. lines. The power house, 35x120 ft., has a concrete substructure, with a brick and steel superstructure. The installed equipment consists of two scroll case waterwheels direct-connected to two vertical alternators of 2,500 kva. each. Provisions have been made in the power house and forebay for the future installation of a 5,000-kva. unit. All concrete structures rest on solid rock.

Access and Plant Installation—Isolation was the first construction obstacle, Fig. 1. The nearest railroad point was Winton, two miles across the lake, on the Duluth & Iron Range R.R. An old road with heavy grades ran around the lake from the town to within a mile of the site. A new road was built from this point in to the project through an extremely rough country. Across the river from the power house, a long peninsula runs out into the lake. Camp was located here and a footbridge built across the river to the work.

The first two problems which presented themselves were getting equipment in and locating aggregates for concrete. It was decided to use water transportation for bringing in all equipment and material. Two old scows were located at Winton, which formerly had been in the service of a large lumber company. Both of these were under water and had been out of service for years. These were raised, repaired and floated. An old dock at Winton was rebuilt, which enabled cars to be run out and the contents to be loaded directly onto the scows. A 5-ton winch-operated stiff-leg derrick was installed at this point to handle equipment and material. A gravel pit was located directly across

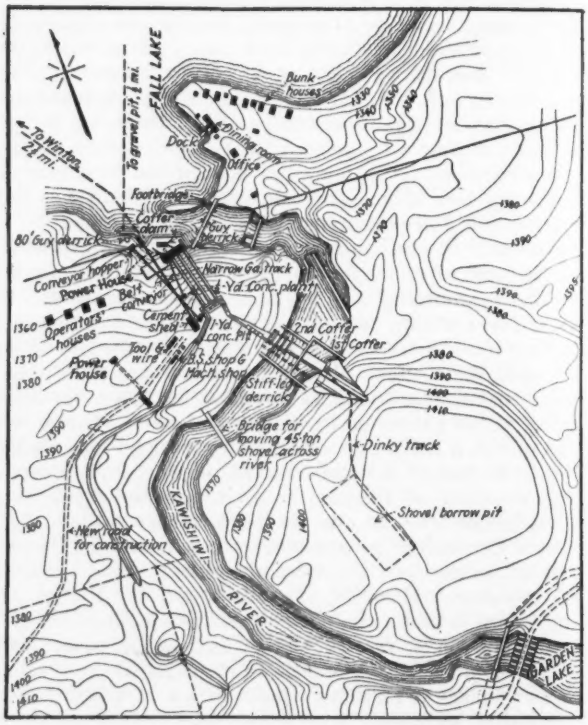


FIG. 1—CONTOUR MAP SHOWING POWER DEVELOPMENT AND CONSTRUCTION PLANT

the lake from the site a distance of one-half mile. With this pit in mind and scow transportation for all material and supplies, the plant was laid out.

An unloading dock in the form of an obtuse angle was built at the mouth of the river, directly below the power house and just clear of the tailrace excavation. A guy derrick was set up to command control of scows coming in to both sides of the dock. That part of the dock which paralleled the river was used for unloading sand and gravel scows and the other part for outfit and material. When this derrick was set up, provision was made for storage space for sand and gravel. A narrow-gage track was laid on the material dock and ran straight up the hill to the concrete plant and cement

shed. By means of a steam hoist and cable all outfit was hauled up this track and later cement and other material. Adjacent to the steam hoist, two horizontal boilers were installed. These furnished steam for the track hoist, concrete tower hoist and heat for the material bins. A one-yard mixing plant was set up in the angle between the forebay and the west non-flow wall and a 175-ft. wood tower raised. From the aggregate stock piles at the foot of the hill to the mixing

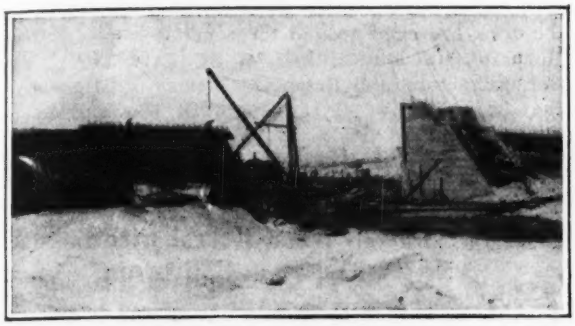


FIG. 2—WINTER PLACING OF CONCRETE IN DAM

plant, a 450-ft. belt conveyor was built on a 17 per cent grade. A belt conveyor was also installed from the cement shed to the mixer hopper. The lower end of this conveyor was built below the floor level of the cement shed so that cement sacks could be emptied easily. The upper end emptied directly into the receiving hopper of the mixer. A housing was built around the entire length. The power to run it was taken from the mixer motor by means of a countershaft. Directly back of the cement shed, yard room was cleared off and the machine shop and warehouse were erected along the road which was built in to the work. A 2,300-volt power line was extended out to the site from a point about 3 miles distant and electric power was utilized wherever possible.

Construction Plan and Procedure—As soon as the new road was completed, a 1-cu.yd. shovel mounted on crawling traction was moved in overland from a small siding, a distance of about 4½ miles, and work on the forebay excavation was started. This material was hardpan, boulders and solid rock. The materials from this excavation were hauled out by two six-ton gas dinkies and used in making the embankment on the west bank of the river. This material contained a large amount of loose rock. As far as possible all loose rock was worked out to the downstream side of the embankment and all rock over 6 in. was either used for paving the upstream slopes or wasted. This shovel was afterwards moved across the river where another embankment was made using the same hauling equipment. When this work was completed the shovel was moved across the river again and used during the winter months as a crane reclaiming stock piles. In the spring it was used as a dragline to take out the pipe line excavation. This excavation was a very heavy material, consisting of clay and large boulders and the machine was working on about a 25 per cent grade. After completing this work the machine was again rigged as a shovel and moved to the switchyard which involved some heavy excavation.

About the time that the shovel was moving in, work was started on the first cofferdam, embracing the east retaining wall and a part of the spillway. A traveling stiff-leg derrick was set up on the upstream side of the cofferdam. The first material was taken out with skips and wasted within the radius of the derrick. Later, as the yardage piled up, due to greater depth than had been figured on, the material was dumped into cars, hauled upstream and wasted. The depth of excavation in the spillway section averaged 27 ft., through boulders, clay, quicksand and shale to bedrock. Steel sheeting was driven on the river side of the coffer where in some places the excavation was 40 ft. below the river bed.

In pouring concrete in this section, provision was made for passing the river through the work while the second river section was being completed. Two 6x10-ft. sluices were left through the spillway and two sliding wood doors were framed and hung in guides over these two openings. Two 2x2-ft. shafts, one for each sluice, were left in the top of the spillway for placing concrete after closure was made. When work in the second section was completed, the gates were cut loose and dropped into place. Great care had been taken in fitting these gates so that when the head started rising very little leakage was noted. Most of this was shut off by calking with oakum and the balance of the water piped through the sluice and capped after concrete was placed.

While the excavation was in progress in the spillway and forebay the concrete plant was set up and the gravel washing plant across the lake was built and put in operation. This plant consisted of a 1-cu.yd. dragline operated by a special dragline engine, two 10x6x10-in. pumps, a stationary screen and a sand settling tank. The mast, 80 ft. in length, was set on a crib in the lake and the sand and gravel bins were also set on cribs far enough out to get sufficient depth

FIG. 3—FOREBAY PENSTOCK FORMS SNOW COVERED

of water for the scows. The dragline dumped directly on a rail grizzly and, there being such a high percentage of gravel in the bank, the oversize rejections were wasted. Two scows were used in this operation. They were hauled back and forth by a hauling engine with an endless cable, using a specially designed niggerhead drum. The average time for the trip across was ten minutes and the average load was 35 cu.yd. During this operation, one of the old scows sank with a load of gravel. As it was necessary to get enough aggregate across before the lake froze over, a new scow, 18x64 ft. was built. This scow was completed in six days working day and night shift. In the fall of the year the water in the lake dropped so low that it became necessary to throw a dam across the lower end of the lake at the outlet to get enough water at the landing dock to float the scows.

A small scow 16x40 ft. was built and used for hauling cement and coal from Winton. It would accommodate one carload. Enough cement and coal was hauled in for the summer work and enough to last over that period when the lake was freezing over. This required a storage of 30 cars of cement and 25 cars of coal. After the lake was frozen over the materials were hauled over the ice with teams and trucks. Four cars of cement could be unloaded and towed to the dock in one day. This was loaded directly on a narrow-gage flat car from the scow and hauled up the incline track to the shed. The coal was unloaded with a clam bucket, dumped into the conveyor hopper, run up to a chute at the head end, and carried by gravity to a bin near the horizontal boilers. This was accomplished by installing a swinging gate at the head end of the conveyor, which enabled the operator to direct the material on the belt to either the coal, sand, or gravel bins. Labor on handling coal was cut quite materially by use of this method. Boulders in the channel at the mouth of the river made a serious obstruction to the movement of material scows, but these were finally all removed by mudcapping under water and shooting. Supplies for the camp were handled by a small scow towed by gasoline launch directly to the kitchen dock.

After the work on the main dam and forebay was well under way, the power house cofferdam was started. This was a crib dam, single sheeted and puddled with material taken from the excavation. The cribs averaged 12 ft. wide and 8 ft. high. This material was all handled by a guy derrick set up in the center of the coffer. From this set up it was possible to handle all excavation, install pumps and set hydrocones, scroll cases and superstructure steel. Later it was used to unload the cribs and remove the puddle.

All concrete in the power house and switchyard was poured with a separate ½-cu.yd. plant. It was the original plan to use the large plant for all concrete, but due to the fact that the deep excavation in the river delayed concreting in that section, it became necessary to pour in the power house section and the spillway section at the same time. Accordingly a ½-cu.yd. mixing plant was set up near the main belt conveyor and far enough up the hill to get a gravity fall for concrete cars to the power house. The material bins were filled from the belt conveyor by means of a tripper and the batches were dumped into cars, run by gravity down to a chute which distributed the concrete. Two cars were used on the track. The track arrangement was a gauntlet with the frog set one rail length away from the mixing plant. A continuous cable was clamped to both cars and when one car was filled, the weight of it was enough to start itself and pull the other car up to the mixer. This arrangement was very efficient and enabled a small crew to run as high as 400 batches in a day's pour.

Most of the 25,000 cu.yd. of concrete was poured between the months of October and April and although the winter was extremely severe (as low as 50 deg. below zero), no time was lost on account of the cold weather. Twenty degrees below was the temperature set below which no concrete was poured. The material was heated by grids of 2 in. steam pipes in the bins and the water by a live steam jet in the supply tank. The concrete was protected in the forms by canvas housing and salamanders. In spite of the cold weather, no concrete on the job was frozen.

Preliminary work was started June 20, 1922, and the main dam was completed in March, 1923. Due to a change of ownership in December, 1922, and a resulting change of plans in the power house and forebay, the work on these sections was delayed about six weeks. However, the first power was sent over the transmission line Aug. 20, 1923.

An average crew of approximately 180 men was employed, and during the months of September to January, 1923, when night shifts were working on excavation, the crew averaged around three hundred men. Siems, Helmers & Schaffner, Inc., of St. Paul, Minn., were the contractors, and Ralph D. Thomas of Minneapolis, the designing engineer. All work was carried out under the direction of N. F. Helmers. The plant was built for the Minnesota Power & Light Co.

Analysis of Heaviest Forest Fire Losses in Ten Years in California

FALL RAINS in California put an end to the most disastrous fire season in that state within a decade. Because 1924 was the second successive year of markedly deficient rainfall, the serious fire period was lengthened from two to four or five months with disastrous results. A complete summary of losses, recently made by the local office of the U. S. Forest Service, contains the following figures:

2,439 forest, brush and grain fires.
100 large fires (ranging from 2,000 to 50,000 acres).
827,000 acres burned over.
$5,000,000 worth of natural resources destroyed.
$920,000 spent by U. S. Forest Service fighting fire.
4 fire fighters killed on the fire line.

Reference to the drought and forest-fire menace in California was made in *Engineering News-Record*, July 17, 1924, p. 115, and July 24, p. 157. An analysis of causes gives the following summary: About 32 per cent of all fires were caused by lightning and the remainder, 68 per cent, were "man-made." The latter classification is subdivided as follows:

38 per cent caused by smokers.
13 per cent caused by campers.
14 per cent caused by incendiaries.
8 per cent caused by brush burners.
6 per cent caused by railroads.
4 per cent caused by lumbering operations.
17 per cent miscellaneous causes.

About four-fifths of the total number of fires were on or adjacent to national forests and one-fifth were on state or private lands. California contains about 19,000,000 acres in national forest areas and of this a little less than 2 per cent was burned over in the fires of the past season.

The U. S. Forest Service maintains a permanent force of fire fighters and patrolmen in California forests totaling about 300. During the past season this force at times was augmented by as many as 630 additional men. The state fire-fighting force, normally composed of 25 men, was doubled.

In the battle waged against the fire menace, in addition to the actual fighting in the burning areas, an effort was made to minimize the danger by closing to public use 10,000,000 acres of national forest land and placing on several million additional acres restrictions on camping, hunting and smoking. Warnings against carelessness and rules for fire prevention were widely circulated through the public press, and by means of posters, billboards and road signs.

Tri-State Compact for Utilization of Delaware River

Treaty Drawn on Behalf of New York, Pennsylvania and New Jersey Divides Waters and Provides for Control

A TRI-STATE compact for the allotment of the waters of the Delaware River between the states of New York, New Jersey and Pennsylvania was signed on Jan. 24 by representatives of the three states composing the Tri-State Delaware River Commission. The compact has been submitted to the legislatures of the states and if approved by them and subsequently by Congress it will become a treaty. Besides the allotment, the compact provides for the sanitary protection of the river and for studies looking to the formation of a program for the full utilization of the waters of the stream and its tributaries.

Under this compact each state secures the right to develop within its own boundaries any tributary or any part of any tributary of the Delaware River under its own laws and regulations. But the total drainage area which may be so developed within a state is limited to three-fifths of the total drainage area within that state. All developments for diversion above the common state boundary point near Port Jervis are required to compensate the low season flow during the months of July, August, September and October to the extent of 0.45 sec.-ft. for each square mile of drainage area above the point of diversion. All other developments for diversion, wherever located, must at all times compensate the flow of the channel to the extent of 0.15 sec.-ft. per square mile above the point of diversion.

Allotments—All water flowing in the Delaware River channel *above* Port Jervis is allotted equally to the three states but none of this water may be diverted from the channel unless the flow is greater than 0.45 sec.-ft. per square mile of drainage area above the point of diversion. All water flowing in the channel of the Delaware *below* Port Jervis is allotted equally to Pennsylvania and New Jersey but none of the water may be taken unless the flow is greater than 0.36 sec.-ft. per square mile of drainage area above the place of taking. As each state makes developments on the tributaries its allotment of the water flowing in the channel of the Delaware is reduced by a rule laid down in the compact.

In order to secure the greatest use and benefit of water wherever it may be developed, the channel of the Delaware River is constituted a "carrier" so that water developed at any upper point may be allowed to flow without interference to any lower point where it may be taken out of the channel. The effect of the compensation requirements during the low flow seasons will be substantially to improve conditions everywhere along the channel and the impounding of the flood water will operate to reduce the damage and injury which, at present, is often done.

Under the compact dams may be constructed across the channel of the Delaware River for the development of power and for any other purpose. The treaty of 1783 between Pennsylvania and New Jersey, still in effect, directly prohibits such constructions.

Among other provisions the compact covers all matters relating to the development of water power; it lays down rules for the treatment of sewage and industrial wastes and it recites a policy of forestation and protection against fire in forested areas. It authorizes joint projects as between the states.

The compact further provides that all damages growing out of any development authorized under its provisions are to be determined by the courts of the state in which the damage is suffered. The compact clearly states that no property can be taken without due process of law and upon payment of just compensation. Riparian rights, and vested rights of every kind, are fully protected.

Any Delaware River power development is limited to whatever period of not over 50 years the signatory state may determine, subject to any provision that may be made for extension or renewal and also subject to state recapture on general terms set forth in the treaty. Provision for the usual United States license for water power developments on navigable streams is embodied in the treaty. The treaty further provides:

> No project authorized and constructed under the provisions of this article shall, at any time, be operated so as to affect injuriously any project for municipal and domestic water supply which has been or may be established under the provisions of this compact. Subject to such conditions as the commission may embody in its approval, water for the development of power may be removed from the channel of the Delaware River and carried in a canal or in a pipe to any point below a dam constructed under the provisions of this article, but said water shall be returned to the said channel within a distance of 12 miles below the point of removal measured along the center line of the said channel and there shall always be maintained in the said channel immediately below the dam, such regular and uniform flow of water as the commission may determine to be reasonable and proper.

Necessary equipment for measuring flows is provided for by the compact, these and other supervisory matters to be under the control of a permanent commission, made up of not more than two representatives of each state, to be appointed by the respective state governors and to be known as the Tri-State Delaware River Commission. The permanent commission is to keep all necessary stream flow and diversion records, and report annually to the governors of the three states for the information of the corresponding legislatures. In addition the treaty directs the commission:

> To proceed with a study and investigation looking toward a comprehensive and complete development of all the water resources of the drainage area of the Delaware River and to report the results of such study and investigation to the governors of the signatory states for the information of the respective legislatures.
>
> To make a study of the possibilities for the development of water power along the channel of the Delaware River and to designate tentative locations and heights of dams along the said channel.

The relative "importance and public value" of the waters of the Delaware are thus stated in the compact: "(A) domestic and municipal; (B) sanitation; (C) industry and power; (D) navigation."

The sanitary protection of the Delaware River is provided for in the compact in some detail [following in general the principles agreed to in 1922 by the New Jersey and Pennsylvania Departments of Health; see *Engineering News-Record*, Aug. 10, 1922, p. 243]. The tri-state compact forbids the discharge of sewage or industrial wastes into the Delaware or its tributaries except under the following conditions:

> (1) All sewage discharged or permitted to flow into the channel of the Delaware River above the confluence with the

Lehigh River shall, within a time reasonable for the construction of the necessary works, have been so treated as to remove settleable solids, to render the effluent non-putrescible and to effect a reasonable reduction of B. Coli Communis.

(2) All sewage discharged or permitted to flow into the channel of the Delaware River below the confluence with the Lehigh River shall, within a time reasonable for the construction of the necessary works, have been so treated as to at least remove settleable solids and shall be discharged through submerged outlets into said channel; provided that such submerged outlets shall be located and constructed as may be required by the commission; and provided further, that in order to protect the public health in specific instances such higher degree of treatment shall be used as may be determined to be necessary by the commission after due notice and hearing.

(3) All sewage discharged or permitted to flow into any tributary of the Delaware River, except the Lehigh River, shall be treated to that extent, if any, which may be necessary to maintain the water of such tributary immediately above its confluence with the Delaware River in a sanitary condition at any time at least equal to the sanitary condition at such time of the water of the Delaware River immediately above such confluence.

All sewage discharged or permitted to flow into the Lehigh River shall be treated to that extent, if any, which may be necessary to maintain the water of the Lehigh River immediately above its confluence with the Delaware River in that sanitary condition which the commission, after due notice and hearing, shall have determined to be necessary because of the nature and extent of the use of the water of the Delaware River below such confluence, provided, however, that the commission may not require the sanitary condition of the Lehigh River immediately above its confluence with the Delaware River to exceed that of the sanitary condition of the Delaware River immediately above such confluence.

(4) All industrial wastes discharged or permitted to flow into or be placed in or permitted to fall or move into the channel of the Delaware River or any tributary thereof shall first have been treated to such extent, if any, as may be necessary to maintain in the channel of the Delaware River sanitary conditions equivalent to those which would be attained by the treatment of sewage above required in this article; provided, nevertheless, that industrial wastes containing substances likely, in the judgment of the commission, to produce offensive tastes and odors in any public water supply from the channel of the Delaware River, shall either be wholly prevented from being discharged or from flowing into or from being placed in or permitted to fall or move into said channel or any tributary of the Delaware River, or shall first have been treated to such an extent as to wholly eliminate such taste and odor producing constituents.

The commission which drew up the compact was authorized by the legislatures of the three states early in 1923. Pennsylvania was represented by Dr. Charles H. Miner, commissioner of health, as chairman, Robert Y. Stuart, secretary of forests and waters, and Philip P. Wells, deputy attorney general; New Jersey by W. A. Starrett as chairman and Frederick C. Schneider; New York by George MacDonald as chairman, Rudolph Reimer and Jefferson DeMont Thompson. These three commissions organized as a joint commission by selecting George MacDonald as chairman, Charles H. Miner as vice-chairman and W. A. Starrett as secretary. The compact was drafted by a committee of technical and legal advisers consisting of, for Pennsylvania Charles E. Ryder, chief engineer of water and power resources, George W. Woodruff, attorney general, and Philip P. Wells, deputy attorney general; for New Jersey, H. T. Critchlow, hydraulic engineer, Department of Conservation and Development, and Francis H. McGee, deputy attorney general; for New York, J. Waldo Smith, consulting engineer, Board of Water Supply, City of New York, and Frank H. Deal. Thaddeus Merriman, chief engineer of the Board of Water Supply, City of New York, acted as consulting engineer to the technical advisers on the drafting committee. The United States Government was represented by Lt. Col. John R. Slattery of the Corps of Engineers, and Col. William Kelly of the Federal Power Commission.

Old Foundations Used in Replacing Steel by Concrete Span

Masonry on Pier and Abutment Tops Cut to 5-Ft. Depth and Capped—Concrete Arch with Floor Tie

By F. W. Epps
Kansas Engineering Co., Topeka, Kansas

IN PROJECTING a concrete road from Emporia south a problem was encountered at the crossing of the Cottonwood River. An old 125-ft. steel span had been carrying the traffic across the river and a 30-ft. I-beam approach span had been carrying it over the tailrace of a mill located against the north side of the bridge. The masonry abutments and pier were in excellent condition,

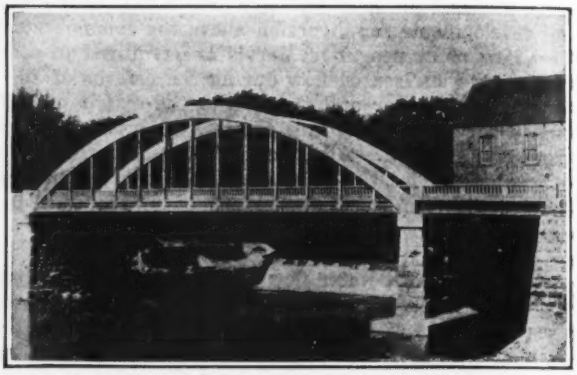


FIG. 1—NEW COTTONWOOD RIVER CROSSING—CONCRETE ARCH ON OLD MASONRY

though the face of the pier masonry at the water level next to the millrace was somewhat disintegrated. It was found on investigation that the old iron span would not carry a concrete floor or the live-load required of a bridge on a federal-aid project and a new bridge was called for by the state highway commission.

The county commissioners and county engineer were strongly opposed to putting in another steel structure at this location and they were anxious to have an arch built using as much of the old masonry as possible. A consultant was called and after considering all features advised the use of an arch with overhead rib and stiff bottom-chord tie, resting on the west abutment and the pier. A 30-ft. concrete girder design was advised for the approach span, with railing and other lines conforming to those of the arch span. As this type of structure fulfilled the requirements of large waterway, long span, high clearance and vertical reactions at abutment and pier, it was adopted by the county commissioners.

Before starting construction on the arch, repairs were made to the tops of both abutments and the pier by cutting away 5 ft. of the top of each or until satisfactory masonry was reached and replacing with a concrete cap in which expansion devices were embedded. A concrete

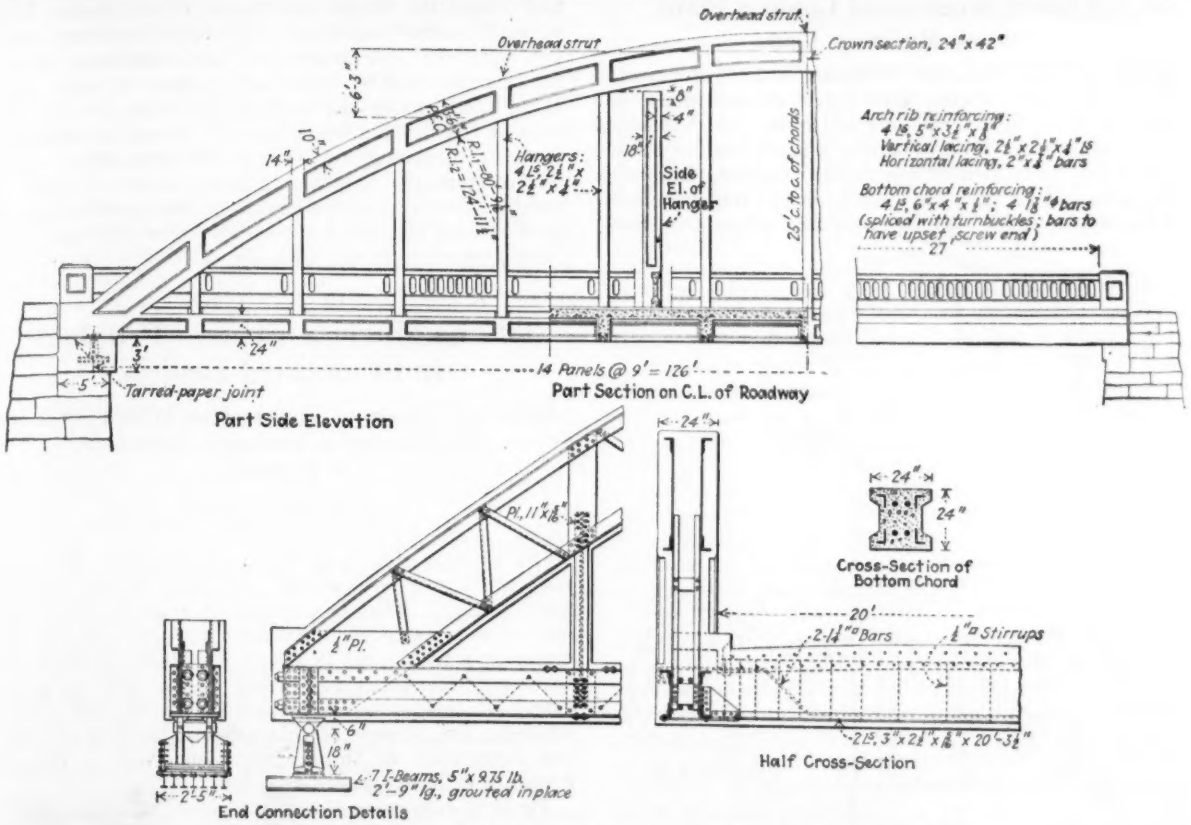

Overhead strut
Overhead strut
Crown section, 24" x 42"
Arch rib reinforcing:
4 ls, 5" x 3½" x ⅜"
Vertical lacing, 2½" x 2½" x ¼" ls
Horizontal lacing, 2" x ⅜" bars
Bottom chord reinforcing:
4 ls, 6" x 4" x ½"; 4 1⅛" ϕ bars
(spliced with turnbuckles; bars to have upset screw end)
Hangers:
4 Ls, 2½" x 2½" x ¼"
Side El. of Hanger
25' c. to c. of chords
14 Panels @ 9' = 126'
Tarred-paper joint
Part Side Elevation
Part Section on C.L. of Roadway
Pl., 11" x ⅜"
½" Pl.
7 I-Beams, 5" x 9.75 lb.
2'-9" lg., grouted in place
End Connection Details
Cross-Section of Bottom Chord
20'
2-1¼" ϕ Bars
½" ϕ Stirrups
2 Ls, 3" x 2½" x ⅜" x 20'-3½"
Half Cross-Section

FIG. 2—CONSTRUCTION FEATURES OF COTTONWOOD RIVER BRIDGE

apron was placed around the pier base to protect it from further wash from the mill race.

The arch ribs were reinforced by four angles 5 x 3½ x ⅜ in., laced on all sides and carrying connection plates at each panel point to which the four hanger angles (2½ x 2½ x ¼ in.) were attached. These hangers were riveted to the floorbeam angles and also to the bottom-chord angles. The bottom-chord reinforcing, consisting of four angles 6 x 4 x ½ in., was augmented by four 1⅛-in. round bars with upset screw ends and nuts bearing on plates riveted to the end stiffeners. These bars were spliced with turnbuckles. The floor slab was carried by floorbeams spaced 9 ft. on centers. The arches were braced by three overhead struts reinforced with four angles 3 x 3 x ¼ in. All connections of the structural steel reinforcement were riveted.

An unusual service was rendered by the consulting engineer in making detail drawings for all falsework and forms used on the job. Each panel of the arch was drawn out and full dimensions given for framing the sections. Details for joists supporting the bottom of the arch rib were drawn, giving ordinates of the curve every 12 in.

The alignment of the forms was maintained by using wedges between them and the falsework bents located under every other panel point.

This bridge was built under the direction of W. S. Ruggles, Sr., county engineer. The Marsh Engineering Co., consulting engineers of Des Moines, designed the structure.

The contract for the construction was given to the Western Bridge Co., Harrisonville, Mo., at their bid of $18,217.62, which covered construction of the bridge, complete.

Plans for Regulating Traffic in Paris

THE PERMANENT circulation committee of the Paris municipal council has drawn up a new series of street traffic regulations made necessary by the progressive congestion of Paris thoroughfares. Between the hours of 3 p.m. and 7 p.m. the circulation of slow-going vehicles is forbidden within an area centering around the Opera quarter. Two cross streets north and south and east and west, lying within this area, are excepted. Thus traffic is hampered as little as possible except that delivery vehicles, horse-drawn vehicles or hand carts of any nature are not permitted to pull up at any point within these limits and are only allowed to cross it by the streets indicated. Included in slow-going vehicles are motor trucks of 8 tons and upward.

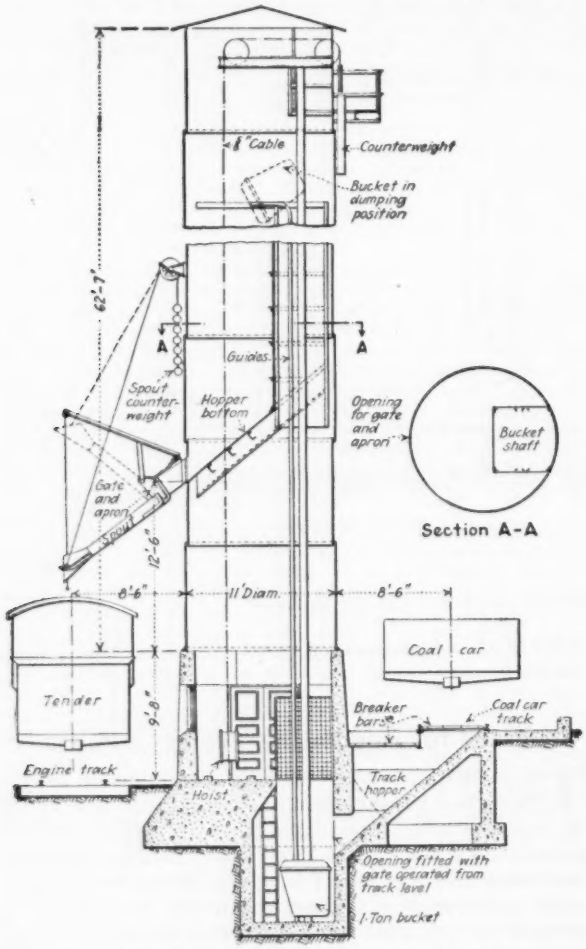
A considerable number of one-way streets have been laid down and a new system of handling traffic by luminous signals at night and colored signals by day is being tried out in the Carrefour of the Opera.

Taxicab chauffeurs are to have a special license book upon which all contraventions will be inscribed. Bonuses will be offered to taxi chauffeurs who may not have transgressed any municipal regulations during the year.

The above measures, together with others which will ultimately remove street car and motor bus terminals from the center of the city, are the first adequate measures which have been taken on behalf of traffic control in Paris since the coming of the automobile.

A Small Mechanical Coaling Plant for Railway Use

FOR SUPPLYING coal to locomotives at railway coaling stations serving only a few engines daily, and also at the coaling stations of mines and industrial plants, there has been developed a small coaling station which can be fabricated practically complete, shipped on flat cars and set in place upon prepared foundations by a locomotive crane. The general arrangement is shown



COALING STATION WITH 50-TON BIN

in the accompanying drawing. Such a plant can readily be shifted to a new position to suit changes in operating conditions.

A 50-ton coal bin is formed by an 11-ft. steel cylindrical shell which is made in two sections, with a bolted ring joint, the lower section having an inclined bottom for the storage bin and an outlet equipped with gate and hinged chute. An interior hoisting shaft is partitioned from the bin and has guides for a 1-ton bucket, these guides being so shaped as to dump the bucket at the top of its travel. This steel shell is mounted on a concrete base which houses an automatic hoist and the foundation of which forms the bucket pit as part of the track hopper.

In operation, the attendant controls the filling of the bucket from the track hopper by means of a drop gate. A pull of a lever then starts the hoist, which raises and dumps the bucket and lowers it for another load, without further attention. The same machinery, with two additional but smaller bins and connecting chutes, can handle engine sand and ashes, a sand drier being fitted under the base of the sand bin. In the base of the ash bin there may be formed a 10,000-gal. tank with hinged spout to supply the locomotives. With this combination only a minimum amount of labor is required for serving the engines. This new design for small coaling stations has been worked out by the T. W. Snow Construction Co., Chicago.

The Engineer's Ethical Problems in Structural Design

Different Classes of Engineering Which Arise in Practice and a Tentative Statement of Principles

BY DAVID C. COYLE
Structural Engineer, New York

SHOULD a structural engineer sacrifice safety to economy, or seek safety first and let the cost be what it may? That is a simple question, to which one can give a categorical answer: the function of the engineer is first of all to assure the safety of the structure, and secondarily to prevent waste. But the application of this principle to practice is no such simple matter. The purpose of this paper is to state in tentative form some of these applications, with a view to arousing criticism and discussion.

Projects of construction are divided, according to the purses and prejudices of the men who furnish the money, into several distinct types, as regards the nature of the engineering work involved.

1. *Incompetent Work*—Where the owners have no conception of the nature of structural safety, and the law does not compel them to take it into full account, they may easily be tempted to take the cheapest way to get a design. Sometimes they find an architect who will do his own designing out of a mill handbook, or a contractor who "furnishes engineering service free." In the first case it is often mere chance whether the design is dangerous or extravagant; in the second, there is small chance of extravagance. The Knickerbocker Theater seems to have been a shining example of free engineering service. A full account of this case ought to be published as advertising matter by the engineering societies and distributed to owners and architects.

Competent engineers have nothing directly to do with the first class of work except to struggle with its effects. Sometimes, through the insistence of a mortgagee or other interested party, we are called on to check designs of this class. It is an illuminating experience, and leaves one with a feeling of mingled amusement and horror. More frequently we are called upon to compete in economy with standards established in the minds of owners who have seen cheap work and have no intention of paying more for their own. Examples of structures which have not yet fallen down are to be found everywhere, and are frequently cited as standards of practice, to exceed which is reckless extravagance.

2. *Cheap Work*—It is here that we have the second class of projects: those in which the owners, realizing that safety from collapse and damage suits is a tech-

nical problem, or faced by the necessity of "passing" a fairly competent building department, are prepared to pay for architectural and structural design but are determined on the cheapest construction that will "get by" and stand up. In such a case the ethical problem for the engineer is acute and persistent.

From the owner's point of view the building law represents the requirements of safety. He will pay for anything the law requires and no more. Where the law is non-committal he will pay for the type of construction which customarily "gets by" the building department, and no more. The primary ethical question is whether an engineer can accept work on this basis. The answer seems to be only another question: with the law and the examiners in question, will the engineer be able to satisfy the owner's demands without perpetrating an unsafe design? In New York this is usually possible. Though unsafe designs have often "gotten by" here, it remains true that work in which there are no unusual or obscure features is usually held to a fairly uniform minimum requirement. Moreover, the unit stresses in New York are so conservative that a design may be "skinned" to the limit of the law without becoming directly dangerous. But in places where the code is less strict, skinning may easily verge on criminal recklessness.

The following propositions are put forward tentatively as a statement of the ethics of cheap work:

(a) If the owner wishes to build a structure the life of which will be short, and which will probably be condemned and torn down in twenty years, there is no reason in public interest why he should not do so.

(b) The fact that a structure, such as a wooden bridge or a cheap building, will become unsafe in course of time, cannot in practice be regarded as a reflection on the morals of its designer. Any such counsel of perfection leads to absurdity.

(c) The engineer should respect the law as a safeguard against dishonesty or incompetence, but not as a rule of practice. He should have his own standard, which may be more conservative than the law in some respects and more radical in others.

(d) It is unethical to design below one's own idea of safety even though the building examiner may be too incompetent to recognize the fact. In New York this applies usually only to strange and obscure features, outside the ordinary experience of the examiners. To depend on the Building Department for safety in such cases is unethical.

(e) It is not unethical to take advantage of common practices such as the omission of the weight of columns and their covering in small buildings, provided the result is conservative. It is not unethical to use a formula which the engineer knows to be fallacious, e.g., the "triangular" formula for footings, provided he is convinced that the result is conservative. The engineer is justified in regarding all loads and stresses as nominal, even though the examiner may think them actual. For the engineer, the computations are not laws but guides to the use of judgment, and he is the sole judge of the sizes to be specified in the original design. He is justified in expecting the building examiner to take sole responsibility for the legality of the design. In a word, when the engineer believes the examiner to have misinterpreted the law in his favor it is ethical for him to accept the examiner's approval if the design is safe according to his own standards.

3. *Ordinary Work*—Where the owner is not aiming to get a cheap structure, but desires a reasonable degree of permanence, it is the duty of the engineer to have a thorough understanding with the architect as to the desired relation between safety and expense. The ethics of this class of work consists simply in giving the owner what he thinks he is getting. The design should be consistent, equally conservative in all its parts. It is unethical to save trouble by "slapping in" material, but it is justifiable to add material not required by the computations, if the added substantial quality is such as the owner wants. Misunderstandings should be avoided by frequent discussion with the architect as regards live-loads, unit-stress systems and material added "for luck." With this simple precaution, the engineer can feel that he has covered his ethical duty. In return, he is entitled to be assured that the owner will not have the work redesigned by another engineer with a view to economy.

4. *Monumental Work* — Public buildings and other structures in which solidity and permanence far outweigh first cost require a different attitude of mind. Suppose the engineer competent to make the design; he owes two things to the owner:

(a) He must not be slovenly. To waste material in places where it will do no good because he is too lazy to make the necessary computations is all the more unethical because it is often impossible of detection. The design should be figured as carefully as a "skinned" job, and any material added should be placed intelligently with a definite purpose in mind. The architect should be satisfied of the value, if not of the necessity, of every added expense.

(b) The engineer should not fail in vision. As the intended life of a structure is greater, it is the more important to think in terms of corrosion, disintegration, war, earthquake, neglect—the long-time or infrequent factors of destruction which we generally omit in ordinary work. We should not attempt to aim at the far future without stretching our minds to take in the lapse of time. Monumental work in these days should be done in the light of modern engineering knowledge, with a full sense of the past, and in the spirit of prophecy. It is here that we have as true an inheritance from the Egyptians, the Greeks, and the men who built Stonehenge, as have the architects. What beauty and dignity are to the architect, solidity and permanence are to the engineer. For both, good monumental work demands not only the skeleton of mathematics and rules, but the living body of a creative art, and the sense of spiritual adventure.

It is in the three last-mentioned distinct types of engineering—cheap, ordinary, and monumental—that we find engineers actually working, not in the colorless "good practice" of the text-books. One sometimes wonders whether the writers of "works" are conscious of the fact that most engineers do not figure the bend point of reinforcing bars to the nearest inch, and that the actual standards of practice are in many respects incommensurable with those found in the books. Is there a convention that however we actually work we must talk like a political platform, or is it a conspiracy to keep any but the initiate from knowing how design is really done? Or is it merely a natural shyness about admitting that our everyday work does not always coincide with the results of the slope-deflection theory? A little frank discussion would perhaps blow away some of the cobwebs.

Drainage and Flood Protection of an Industrial District

Greater Pumping Capacity Required than for Agricultural Lands—Hydraulic Fill Levee Constructed Along Missouri River—Large Conduit Instead of Ditch

BY O. H. HORNER
Horner & Wyatt, Engineers, Kansas City, Mo.

THE HANDLING of rainfall and seepage water has proved the greater problem in the new Fairfax Drainage District, Kansas, although protection of the land from flooding by the Missouri River was the principal purpose of the project. Among the unusual features are the development from agricultural to industrial use of the land, a combination of gravity discharge and pumping, and the use of a closed conduit

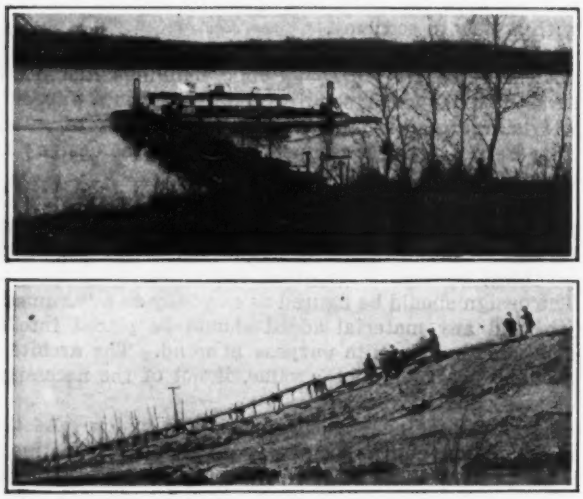


FIG. 1—HYDRAULIC FILL LEVEE CONSTRUCTION
Above—electrically operated dredge. Below—bottom discharge from pipe line.

and sewer in place of an open ditch. The levee construction is shown in Fig. 1. This district, shown in Fig. 2, comprises 1,705 acres of bottom land in a bend of the river north of and adjacent to Kansas City, Kan., with a small area within the city limits. Practically all the land is cleared and was under intensive cultivation when the district was organized in 1922. A small part at the south end, near Jersey Creek, has been subject to annual overflow, but the larger part is above ordinary high-water stage. The main problem has been the handling of rain and seepage water from the district and from 1,144 acres of adjacent hill land.

Hydraulic Fill Levee—Protection against the river was provided readily by a 5-mile levee and 6,000 ft. of embankment along the foothill ditch. As the soil was not suitable for levee work it was decided to use sand from the river, and examination showed that the cost by hydraulic dredging would be less than by the use of dragline excavators, especially as land for borrow pits would cost more than the land for the levee. The sand is deposited in place by means of bottom gates in the discharge line (see Fig. 1) and the desired slope is given by boards held in place by stakes. Construction was commenced in May, 1923, and completed in July, 1924.

This levee consists of about 450,000 cu.yd., all placed with a dredge having a motor-driven 12-in. centrifugal pump, with a 12-in. discharge line having a maximum length of 1,300 ft. The height is 8 to 20 ft., with a top width of 8 ft., or 6 ft. where the river face is paved. Both sides are sloped 1 on 3, except that where the height exceeds 10 ft. the land slope is 1 on 4. For about 4,000 ft. where the current was expected to be dangerous, the outside face was protected with a stone revetment. At this same place and for some distance above and below it, the original bank had been protected by the U. S. Government in 1884 with ballasted willow mattress and stone revetment, which is still in good condition. As the river was undercutting the bank adjacent to the levee and below Goose Island, it was thought necessary to protect 6,500 ft. of the bank in the same way, but the face of the levee was not protected as the high-water current is not dangerous at this point.

The top of the levee is 3 ft. above the high-water stage of the Missouri River in 1903, which is the highest water known since 1844, when it was approximately two feet higher than in 1903. It is expected that eventually the industrial importance of the district will make it advisable to raise the levee at least 3 ft.

Interior Drainage System—The 1,144 acres of hill lands which drain through the district are mostly covered with short grass, but some parts are fairly well built up and have paved streets, so that the percentage of the runoff is high. The runoff from the district is correspondingly low, the land being nearly flat alluvial soil and practically all under cultivation, but this condition will be radically changed as the district is transformed from an agricultural to an industrial char-

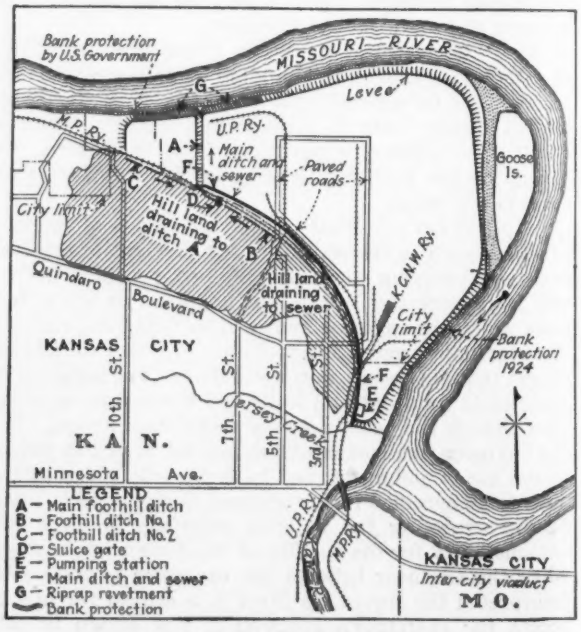


FIG. 2—FAIRFAX DRAINAGE DISTRICT, KANSAS

acter. In view of this development, it was thought necessary to provide sufficient pumping capacity to pump the maximum rate of flow against the head developed by extreme high water and thus to protect the district from inundation even for very short periods, a condition not so necessary in a purely agricultural project.

When this condition was applied to the probable

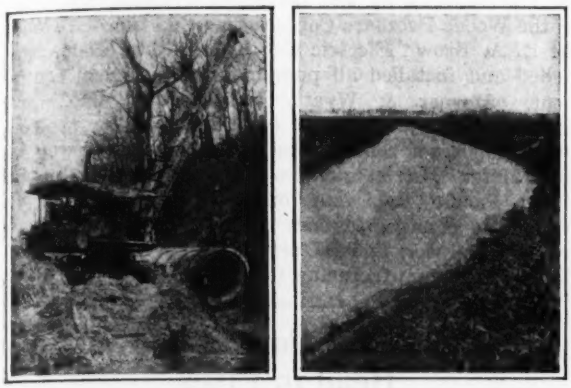


FIG. 3—WORK ON THE FAIRFAX DRAINAGE DISTRICT
At left—laying 68-in. concrete pipe with dragline machine.
At right—the foothill drainage ditch.

maximum rates of runoff from a total of 2,849 acres, the result was a pumping problem of enormous proportions. It was found, however, that 940 acres of the hill land within the city could be drained into a foothill drainage system so designed as to cause water to flow to the Missouri River under its own head. This necessitated raising the embankment along the foothill ditches to an elevation equal to that of the levee, plus sufficient height to offset the hydraulic gradient of the ditch water. The main foothill ditch, Fig. 2, extends from the river to the bluff and adds 6,000 ft. to the length of the levee. Foothill ditches 1 and 2 pick up the several small ravines and streams leading down the hillsides and conduct them to a point where the water is taken under the Missouri Pacific Ry. in 64-in. and 84-in. concrete pipes. Since the river at high water will back through these pipes, the embankments along the ditches were raised from 1 to 7 ft. higher than the levee. The laying of a 68-in. concrete pipe drain is shown in Fig. 3.

A sluice gate was provided in ditch 2 as an extra precaution to prevent the possibility of river water backing into the district. With the introduction of the foothill drainage system, the pumping equipment was reduced more than half. A small territory within the city limits, that lying east of 5th St., is drained into the main interior ditch, together with all the runoff from the district itself, this flow being conducted to Jersey Creek. The water from that portion of the district above the main foothill ditch is carried over the top of the concrete pipes in a 36-in. pipe and thence to Jersey Creek.

Storm Water and Sanitary Sewer—It was intended originally to have an open drainage ditch from the intersection of the foothill ditch system with the Missouri Pacific Ry. to Jersey Creek. On account of objections from property owners and the purchase of most of the land in the district by a syndicate for immediate industrial development, it was decided to convert this ditch into a combined storm and sanitary sewer. The ditch has been dug to take care of present needs. The sewer, for which the contract will soon be let, will be 10,950 ft. long, varying from a double box 9x9½ ft. inside at the lower end, Fig. 4, to a single box 5x5½ ft. at the upper end. It has an average slope of approximately 1 in 1,000, the actual slope in the several sections ranging from 0.065 to 0.125 per cent.

Designed to take care of the entire district when developed into an industrial center, the maximum capacity of the sewer at the outlet end is 1,130 sec.-ft. On account of the elevation, only the lower portion of the sewer will serve the Fairfax District as a sanitary sewer and even this may be found impracticable on account of pumping conditions. It will serve Kansas City, Kan., as a storm and sanitary sewer. The city will soon construct a 30- and 24-in. sanitary sewer extending west for about a mile from the upper end of this main sewer. About 475 ft. of the double-box sewer have been built to pass under railroad tracks and two short sections of sewer were built at public crossings.

Pumping Plant—There is but one pumping station, located at the outlet end of the sewer. The unit already built, Fig. 5, consists of a brick and concrete building 34x86 ft., with one 24-in. and five 42-in. horizontal centrifugal pumps driven by 75- and 250-hp. motors respectively. Power is obtained from the municipal power plant at Kansas City, Kan. These pumps draw water from a concrete suction chamber occupying the entire basement and discharge into a concrete pressure tunnel through which the water is forced into Jersey Creek and flows thence to the river. The total present pumping capacity is 575 sec.-ft. when operating against the average head, or 460 sec.-ft. at maximum head.

It is estimated that this capacity will be sufficient for at least ten years, when the station will have to be extended and ultimately its capacity will have to be doubled. There are no suction valves on the pumps, but each has an electrically operated gate valve on the

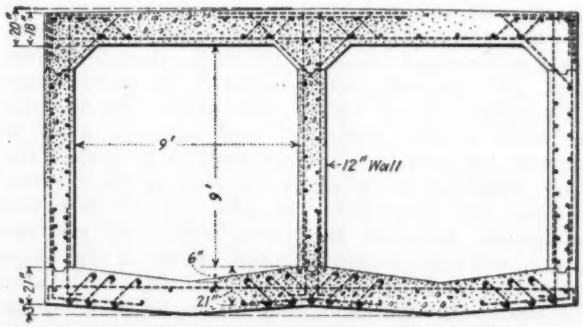


FIG. 4—CONDUIT REPLACES OPEN DITCH

discharge, to prevent river water running back to the sewer through the pumps. Duplicate motor-driven vacuum pumps are provided for priming. Inside the pumping station is a vertically sliding steel gate 11½x11½ ft., manually operated by tiller wheels through two bevel gears and two 3-in. square-threaded brass screws. At the outlet end of the discharge tunnel, is a rectangular wooden flap gate for emergency use.

The interior ditch system is so laid out that it will be possible to relieve the pumping station and sewer by segregating 140 acres of land at the west end of the district. This land would be served by a small station pumping into the main foothill ditch.

River Bank Protection—A contract for river bank

protection from Goose Island to Jersey Creek was let in March, 1924, and is about 60 per cent completed. This work has the peculiar characteristic of being useful only at low-water stages, for at high water the current at this place is in midstream, the point of attack on the right bank being below the mouth of the Kaw River. When this condition exists, which is at least once each summer, a bar 200 to 500 ft. long is formed along the right bank from Goose Island to the mouth of the Kaw. As the river falls, the point of attack moves up along the right bank until at about 3 ft. above standard low water it reaches the lower end of the slough behind Goose Island. Low-water stage usually continues for a period long enough to permit the current to remove the entire bar. The writer has observed the bank carefully for the past

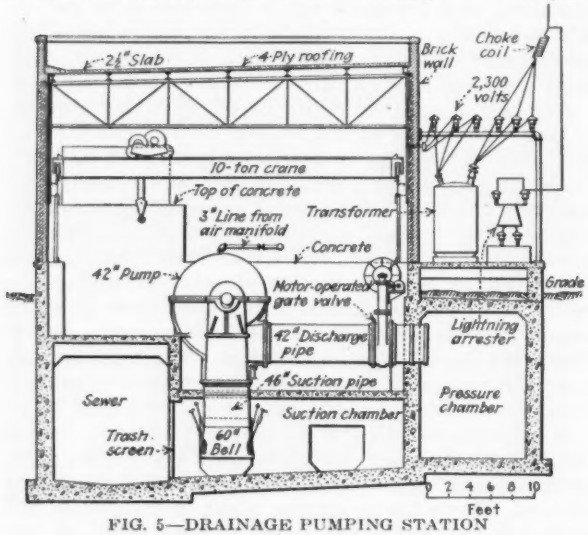


FIG. 5—DRAINAGE PUMPING STATION

three years and each time the low-water current has not only removed the bar but has undercut and washed away an increased amount of the bank. Bank protection was, therefore, considered necessary to prevent further erosion at low water. The willow mattress will be under a heavy deposit of mud whenever a bar is formed, but will be in proper position to protect the bank when the bar is again removed by the current.

Costs and Quantities—The total cost of work and equipment, including the storm water and sanitary sewer, will approximate $925,000. Some of the major quantities and costs entering into the work are: 450,000 cu.yd. hydraulic sand fill in levee, including clearing and grubbing of right-of-way, 26c. per yard; 187,000 cu.yd. earth excavation in ditches, including clearing, grubbing, overhaul and preparing and sodding embankments, 28½c. per cubic yard measured in cut; 3,100 cu.yd. earth excavation and backfill under railroad tracks, $2.50; 976 cu.yd. rock excavation at $3.72; 192 lin.ft. of 84-in. concrete pipe furnished and laid under railroad track, not including excavation and backfill, $29.74; 1,041 lin.ft. of 68-in. concrete pipe under railroad track and along right-of-way, not including excavation and backfill, $21.91 per foot; 604 lin.ft. of 68-in. concrete pipe off of right-of-way, not including excavation and backfill, $20.64; 240 lin.ft. of 36-in. vitrified clay pipe on tamped backfill, $7.48; 565 cu.yd. of concrete in retaining walls, bulkheads and curtains, etc., including steel and forms and excavation and backfill, average $34.20 per cubic yard; 15,000 sq.yd. stone revetment on levee and ditches, $1.48; 4,500 lin.ft. bank protection, average $20 per linear foot; pumping station, with pressure and discharge tunnels, brick superstructure, traveling crane and sewer gates, $89,000; pumping equipment, including transformer substation, furnished and erected, $97,888.

All general construction work, including the pumping station building and the sewer sections, was done by the Woods Brothers Construction Co., Lincoln, Neb.; the E. A. Brown Electric Co., Kansas City, Kan., furnished and installed all pumping and electrical equipment. Horner & Wyatt, Kansas City, Mo., are designing and supervising engineers on the project. Other important construction work now under way in the Fairfax District includes six miles of track by the Union Pacific Ry., four miles of paved roads by Wyandotte county; foundry buildings by the Fairfax Iron & Steel Co.; and factory buildings by the Kansas City Can & Manufacturing Co.

New Tables for Computing Loss of Head in Pipes

Darcy Coefficients for Use in the Chezy Formula, a Relation Between f in the Chezy Formula and the Exponential Formula

By J. O. Jones
Associate Professor of Hydraulics, University of Minnesota

THE BEST known formula for calculating the loss of head in pipes is the Chezy formula,

$$H' = fLV^2 \div D2g,$$

in which

H' is the loss of head,

L is the length of the pipe,

D is the diameter of the pipe,

$V^2 \div 2g$ is the velocity head due to the velocity V, and f is an abstract number called the coefficient of friction.

In English units H', L, D and $V^2 \div 2g$ are expressed in feet.

For computation purposes this formula is very simple. The difficulty in applying it arises in selecting the proper value of f. The tables of values of f here given probably will not be of much assistance to the hydraulics expert but may be some help to the young engineer.

In making computations for straight pipes, engineers now generally use pipe-flow tables which show directly the loss in head per 1,000 ft. of pipe for a given diameter and velocity of discharge. Such tables could equally well have been presented, and if so would have been more convenient for such computations. On the other hand, for some problems it is more convenient to use the Chezy formula directly. If a friction head table is desired for any one of the formulas for which the friction cofficients are given, it can easily be made up by simply multiplying the friction coefficient for a given velocity and diameter by the factor $LV^2 \div D2g$, L, length of pipe, usually taken as 1,000 feet.

In problems involving concentrated losses of head, such as bends, valves, sudden enlargements or contractions, meters, etc., or problems involving compound pipes of different materials, it is easier to work in terms of the velocity head. Usually the concentrated loss is expressed as some constant times the velocity head, i.e.,

$$H' = KV^2 \div 2g,$$

TABLE I—COEFFICIENT OF FRICTION FOR NEW CAST-IRON PIPE
From a formula by F. C. Lea

Diameter of Pipe, In.	Velocity, V, Feet per Second							
	1	2	3	4	6	8	10	15
4	.0305	.0290	.0282	.0276	.0269	.0264	.0259	.0252
6	.0276	.0263	.0256	.0251	.0243	.0239	.0235	.0228
8	.0257	.0245	.0238	.0233	.0226	.0222	.0218	.0213
10	.0243	.0231	.0225	.0220	.0214	.0210	.0206	.0201
12	.0232	.0221	.0215	.0211	.0204	.0200	.0197	.0192
14	.0223	.0212	.0206	.0202	.0196	.0193	.0190	.0184
16	.0216	.0206	.0200	.0196	.0190	.0187	.0184	.0179
18	.0210	.0200	.0194	.0191	.0185	.0182	.0179	.0174
20	.0204	.0194	.0189	.0185	.0180	.0177	.0174	.0169
24	.0195	.0186	.0180	.0177	.0172	.0169	.0166	.0162
30	.0184	.0176	.0171	.0167	.0162	.0159	.0157	.0152
36	.0176	.0168	.0163	.0160	.0155	.0152	.0150	.0146
42	.0170	.0162	.0158	.0154	.0150	.0148	.0145	.0141
48	.0164	.0156	.0152	.0149	.0145	.0142	.0140	.0136
54	.0159	.0152	.0147	.0144	.0140	.0138	.0135	.0132
60	.0155	.0148	.0143	.0141	.0136	.0134	.0132	.0129

TABLE II—COEFFICIENT OF FRICTION FOR OLD CAST-IRON PIPE AND RIVETED IRON OR STEEL PIPES*
From formulas by F. C. Lea

Diameter of pipe In.	Cast Iron	Riveted	Diameter of Pipe In.	Cast Iron	Riveted
4	.0507		36	.0293	.0245
6	.0458		42	.0282	.0236
8	.0427	.0356	48	.0273	.0227
10	.0403	.0337	54	.0265	.0271
12	.0386	.0322	60	.0258	.0215
14	.0371	.0310	66		.0210
16	.0359	.0300	72		.0205
18	.0349	.0291	78		.0202
20	.0340	.0284	84		.0197
24	.0324	.0271	90		.0194
30	.0307	.0256	96		.0191

* Since in these formulas the loss of head varies exactly as the square of the velocity, for a given diameter of pipe "f" will be the same for all values of velocity.

although it is frequently expressed as the equivalent number of diameters length of pipe. Thus the loss in ordinary 90-deg. screw elbows is equivalent to the loss in about 40 diameters length of pipe; a Tee is double an Ell; globe valves, wide open, 500 diameters length; gate valves, 10; Venturi meters, 100 to 1,200, depending on the ratio of throat diameter to entrance diameter, etc. A length of straight pipe equivalent to these concentrated losses may be added to the actual length of straight pipe in the line and the problem solved as a straight-pipe problem. For such problems, however, many engineers prefer the old method of working in terms of velocity head, i.e.,

$$H' = \frac{V^2}{2g}\left(\frac{fL}{D} + K_1 + K_2 + K_3 + \text{etc.}\right),$$

the summation contained in the parenthesis expressing the quantity by which the velocity head is to be multiplied to give the loss of head from that source.

It has long been known that in most cases the loss of head does not vary exactly as the square of the velocity, and hence f cannot be a constant. Moreover, the loss of head does not vary exactly inversely as the first power of the diameter. Consequently f will vary with the diameter also. Hence it is that many attempts have been made to devise a formula not subject to this difficulty. This has resulted in a great many of the so-called logarithmic or exponential formulas, which are of the form

$$H' = kLV^n \div D^m,$$

in which k, n and m are constants. If in this formula we put $K = f \div 2g$, $n = 2$, and $m = 1$, we would have the Chezy formula.

Because of the widely varying character of pipes it has been found impossible to devise a formula of this type that would be applicable to all kinds of pipe. Therefore many proposals have been made to classify pipes as to kind—wood, cast-iron, etc.—and have a particular formula for each kind of pipe. Prof. Osborne Reynolds was among the first to attempt a formula of this kind (1883). Professor Unwin in 1886 proposed the formula

$$H' = 0.0004\,LV^{1.97} \div D^{1.4}$$

for new cast-iron pipes, and

$$H' = 0.0007\,LV^2 \div D^{1.1}$$

for old cast-iron pipes. Lampe and Flamant also proposed formulas of this type at about this time. Later well-known formulas are those of Hazen and Williams, Tutton, Lea, Barnes, Moritz, Scobey, King and a very recent one by Prof. C. I. Corp of the University of Wisconsin for black iron or steel pipe.

Prof. F. C. Lea, in his book on Hydraulics, points out that even for a given kind of pipe the values of k and n vary between wide limits while m is more nearly constant. He suggests, therefore, that formulas of this type should express an upper and lower limit, particu-

TABLE III—COEFFICIENT OF FRICTION FOR GALVANIZED IRON PIPES
From a formula by F. C. Lea

Diameter of Pipe, In.	Velocity, V, Feet per Second							
	1	2	3	4	6	8	10	15
¾	.0542	.0499	.0475	.0458	.0436	.0422	.0411	.0391
1	.0506	.0466	.0443	.0428	.0408	.0394	.0384	.0365
1¼	.0475	.0437	.0417	.0402	.0383	.0370	.0361	.0343
1½	.0426	.0391	.0373	.0361	.0344	.0332	.0323	.0308
2	.0401	.0369	.0351	.0339	.0324	.0312	.0304	.0290
2½	.0384	.0354	.0337	.0325	.0310	.0299	.0291	.0278
3	.0364	.0335	.0319	.0308	.0294	.0284	.0276	.0263
4	.0340	.0313	.0298	.0288	.0274	.0265	.0258	.0246
5	.0321	.0295	.0281	.0272	.0259	.0250	.0243	.0232
6	.0306	.0281	.0268	.0259	.0247	.0238	.0232	.0221
8	.0287	.0264	.0251	.0243	.0231	.0224	.0218	.0207
10	.0269	.0248	.0236	.0227	.0217	.0209	.0204	.0194
12	.0258	.0237	.0226	.0218	.0208	.0201	.0196	.0186

Iron pipe larger than 12-in. is O.D. pipe and the inside diameter depends upon the thickness, which varies from ¼ to 1 in.

TABLE IV—COEFFICIENT OF FRICTION FOR CONCRETE PIPE
From a formula by H. W. King

Diameter of Pipe, In.	Velocity, V, Feet per Second							
	1	2	3	4	6	8	10	15
8	.0356	.0321	.0302	.0289	.0272	.0261	.0252	.0237
10	.0337	.0306	.0286	.0274	.0258	.0246	.0238	.0224
12	.0322	.0291	.0273	.0261	.0246	.0236	.0228	.0214
14	.0310	.0280	.0263	.0252	.0237	.0227	.0219	.0206
16	.0300	.0271	.0255	.0244	.0229	.0220	.0212	.0200
18	.0291	.0262	.0247	.0236	.0223	.0213	.0206	.0194
20	.0284	.0256	.0241	.0231	.0217	.0208	.0201	.0189
24	.0271	.0244	.0230	.0220	.0207	.0198	.0192	.0180
30	.0256	.0231	.0217	.0208	.0196	.0188	.0181	.0171
36	.0245	.0221	.0208	.0199	.0188	.0180	.0173	.0163
42	.0236	.0213	.0200	.0192	.0181	.0173	.0167	.0157
48	.0228	.0206	.0193	.0185	.0174	.0167	.0162	.0152
54	.0221	.0199	.0187	.0180	.0169	.0162	.0156	.0147
60	.0215	.0194	.0182	.0175	.0164	.0158	.0152	.0143
66	.0210	.0189	.0178	.0171	.0161	.0154	.0148	.0140
72	.0206	.0186	.0175	.0167	.0158	.0151	.0145	.0137
78	.0202	.0182	.0172	.0164	.0155	.0148	.0143	.0134
84	.0198	.0178	.0168	.0161	.0152	.0145	.0140	.0132
90	.0194	.0175	.0165	.0158	.0149	.0142	.0137	.0130
96	.0192	.0173	.0163	.0156	.0147	.0140	.0136	.0128

TABLE V—COEFFICIENT OF FRICTION FOR WOOD-STAVE PIPE
From a formula by F. C. Scobey

Diameter of Pipe, In.	Velocity, V, Feet per Second							
	1	2	3	4	6	8	10	15
2	.0366	.0319	.0294	.0277	.0256	.0241	.0231	.0213
3	.0342	.0298	.0275	.0259	.0239	.0226	.0216	.0199
4	.0325	.0283	.0261	.0246	.0227	.0214	.0205	.0189
6	.0304	.0265	.0244	.0230	.0212	.0201	.0192	.0177
8	.0289	.0252	.0232	.0219	.0202	.0191	.0182	.0168
10	.0278	.0242	.0223	.0211	.0194	.0184	.0176	.0162
12	.0270	.0235	.0217	.0204	.0188	.0178	.0170	.0157
14	.0263	.0229	.0211	.0199	.0184	.0174	.0166	.0153
16	.0257	.0224	.0206	.0195	.0180	.0170	.0162	.0150
18	.0251	.0219	.0202	.0190	.0176	.0166	.0158	.0146
20	.0247	.0215	.0198	.0187	.0173	.0163	.0155	.0144
24	.0240	.0209	.0193	.0182	.0168	.0158	.0152	.0140
30	.0232	.0202	.0186	.0176	.0162	.0153	.0146	.0135
36	.0224	.0195	.0180	.0170	.0156	.0148	.0142	.0130
42	.0218	.0190	.0175	.0165	.0152	.0144	.0138	.0127
48	.0213	.0185	.0171	.0161	.0149	.0140	.0134	.0124
54	.0209	.0182	.0168	.0158	.0146	.0138	.0132	.0122
60	.0205	.0179	.0165	.0155	.0143	.0135	.0129	.0120
66	.0202	.0176	.0162	.0153	.0141	.0133	.0127	.0118
72	.0199	.0173	.0160	.0151	.0139	.0131	.0125	.0116
84	.0194	.0169	.0156	.0147	.0135	.0128	.0122	.0113
96	.0190	.0165	.0152	.0144	.0133	.0125	.0120	.0110

TABLE VI—COEFFICIENT OF FRICTION FOR IRON OR STEEL PIPE, BLACK

From a formula by C. I. Corp

Diameter of Pipe, In.	Velocity, V, feet per Second							
	1	2	3	4	6	8	10	15
¼	.0329	.0307	.0295	.0286	.0275	.0267	.0261	.0251
½	.0315	.0294	.0282	.0274	.0263	.0256	.0250	.0240
1	.0303	.0283	.0272	.0264	.0253	.0246	.0241	.0231
1½	.0283	.0264	.0254	.0246	.0236	.0230	.0224	.0216
2	.0272	.0254	.0244	.0237	.0227	.0221	.0216	.0207
2½	.0264	.0246	.0237	.0230	.0221	.0214	.0209	.0201
3	.0255	.0238	.0228	.0222	.0213	.0207	.0202	.0194
4	.0245	.0228	.0220	.0213	.0205	.0199	.0194	.0187
5	.0236	.0220	.0211	.0205	.0198	.0192	.0188	.0180
6	.0229	.0213	.0205	.0199	.0192	.0186	.0182	.0175
8	.0219	.0204	.0196	.0191	.0183	.0178	.0174	.0167
10	.0211	.0197	.0189	.0184	.0176	.0172	.0168	.0161
12	.0205	.0191	.0184	.0178	.0171	.0166	.0163	.0156

Iron pipe larger than 12-in. is O.D. pipe and the inside diameter depends upon the thickness, which varies from ¼ to 1 in.

larly as regards k and n. Prof. Horace W. King (Handbook of Hydraulics) takes the same view of the matter.

While these formulas are undoubtedly more reliable for the kind of pipe for which they were designed than is the Chezy formula with any hitherto available tables of values of f, their usefulness is doubtful because of their awkwardness in some of the problems cited at the beginning of this article. It is a simple matter, however, to construct tables of values of f for use in the Chezy formula by the aid of the logarithmic formula. Aside from the Fanning tables, which apply only to clean cast-iron pipes, the writer knows of no such tables which can be used with confidence.

Since for a pipe with given length, diameter and velocity, the loss of head is a definite quantity, regardless of the formula by which it is expressed, we may equate the two formulas. Thus,

$$H' = \frac{fLV^2}{D2g} = k\frac{LV^n}{D^m}$$

Solving this for f we have,

$$f = \frac{2gkDV^n}{D^mV^2}$$

In most cases the value of n is less than 2 and the value of m greater than 1. We may write the formula thus,

$$f = \frac{2gk}{V^{(2-n)}D^{(m-1)}}$$

Selecting the logarithmic formula which most nearly represents the character of the pipe at hand it is a simple matter to construct a table of values of f for various values of V and D. Thus Unwin's formula for new cast-iron pipe would give

$$f = \frac{0.0258}{V^{0.12}D^{0.4}}$$

The several tables offered by the writer were computed by this means. Tables I, II and III are from formulas by F. C. Lea, which are said to be based upon the best available data for these pipes. Table IV, for concrete pipes, is from H. W. King's formula; Table V, for wood pipes, from F. C. Scobey, and Table VI, for black iron or steel pipes, from C. I. Corp. Professor Corp's formula is the only one known to the writer which is based upon an extensive set of data collected in one laboratory under the direction of one man. It represents experiments on ½ to 12-in. pipe (*Bulletin* of the University of Wisconsin, Engineering Series, Vol. IX, No. 1). In a sense this is true of Scobey's formula, for his laboratory was the entire United States, but the conditions under which he had to work were not subject to complete control.

While it was stated that Lea and King advocate formulas giving upper and lower limits for k and n, they also give values for these factors which may be regarded as an average, and which Lea calls "reasonable values." It is these average values which were used in computing these tables.

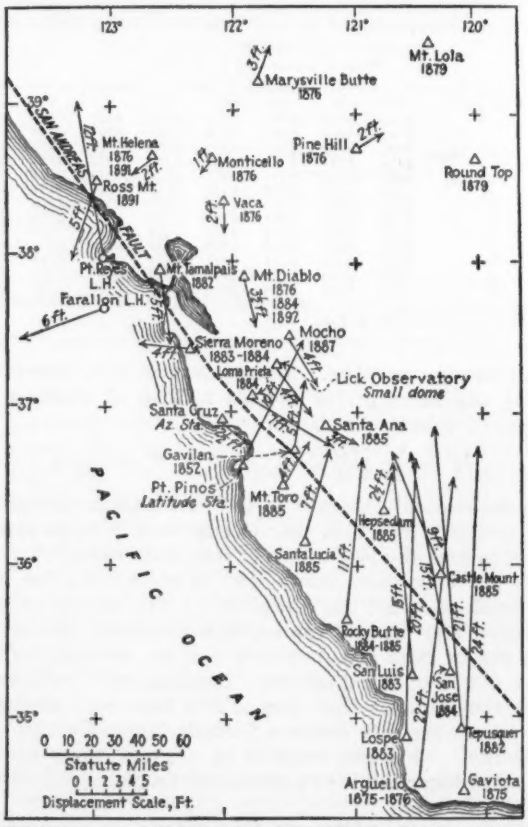
TABLE VII—VALUES OF THE CONSTANTS IN THE FORMULA FOR THE COEFFICIENT OF FRICTION

$$f = \frac{2gk}{D^{(m-1)}V^{(2-n)}}$$

Kind of Pipe	Authority	Values of $2gk$	Values of $(2-n)$	Values of $(m-1)$
Cast iron, new	F. C. Lea	0.0232	0.07	0.25
Cast iron, old	F. C. Lea	0.0386	0.00	0.25
Concrete	H. W. King	0.0322	0.15	0.25
Wood stave, clean	F. C. Scobey	0.0270	0.20	0.17
Riveted iron or steel, clean	F. C. Lea	0.0322	0.00	0.25
Black iron or steel	C. I. Corp	0.0205	0.10	0.16
Galvanized iron	F. C. Lea	0.0258	0.12	0.25

Shift in California Triangulation Stations Shown by Survey

THE U. S. Coast and Geodetic Survey has recently published a bulletin on "Earth Movements in California" written by William Bowie, chief of the Division of Geodesy. The material contained in the bulletin is based largely on the results of the re-occupation of certain precise triangulation stations. The work, begun in 1922, was designed to show whether any move-



MOVEMENT IN CALIFORNIA TRIANGULATION STATIONS

The differences in geographic positions, as computed from the early observations and from the recent ones, are shown by arrows. The direction of each arrow indicates the direction of shift in geographic position during the interval between the two sets of observations. A part of the change in geographic positions is due to unavoidable accidental errors in making the angle observations, but most of the changes seem to indicate actual earth movements. In the computations it was assumed that no earth movements had occurred at stations Mount Lola and Round Top, on the Sierras. These two stations form the base for the computation of the new geographic positions of all the other stations shown on the sketch.

ment had occurred along the coast with respect to the Sierra Nevadas in the eastern part of the state. Stations occupied were both to the north and south of the San Andreas fault, the center of earthquake disturbance in 1906. After the earthquake of that year eleven precise, eight primary and forty-one secondary stations were occupied to determine the difference in geographical position of the stations between the old and new observations, the old observations having been taken as long ago as fifty years.

The pamphlet just issued contains data on stations occupied in the 1906-1907 observations, amplified by data gathered through the occupation of stations included in territory south of that observed in 1906. In fact, the stations upon which the recent report is made stretched as far south as the Mexican border.

In this bulletin of Mr. Bowie's, detailed explanation is given as to the apparent reason for the shift in individual stations. The pamphlet can be obtained from Superintendent of Documents, Washington, D. C. (5c.).

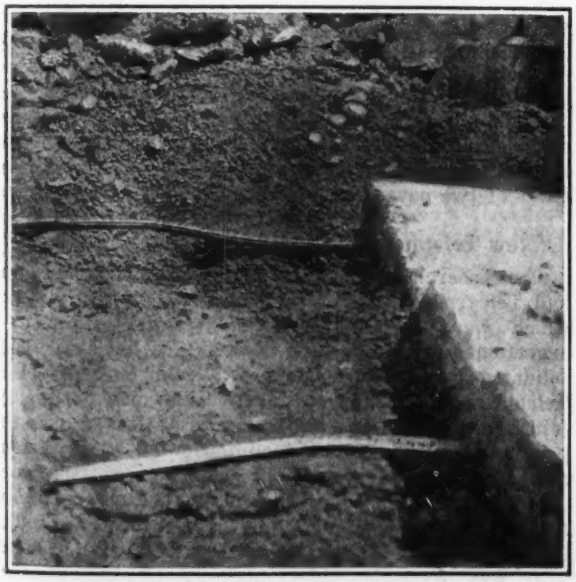
Wide Expansion Joints Stop Blowouts in Brick Roads

By W. A. Stacey

County Engineer, Reno County, Kansas, and Resident Engineer, Kansas State Highway Commission, Hutchinson, Kan.

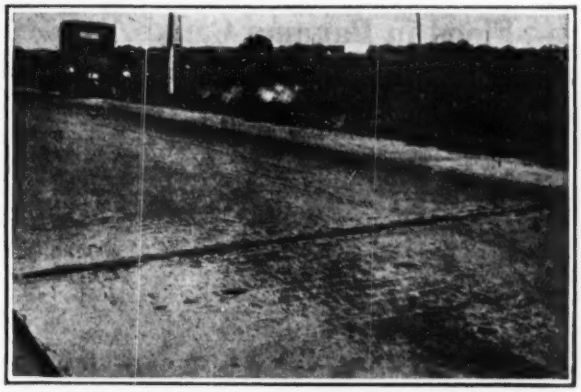
THE USE of wide expansion joints to repair blowouts on 38 miles of monolithic brick pavement in Reno County, Kansas, has been successful in preventing further temperature failures.

The monolithic brick road referred to is a part of Kansas federal-aid projects 15 and 27, whose construction was described in *Engineering News-Record*, Jan. 6, 1921, p. 25, and Feb. 10, 1921, p. 259. The period of construction was from 1919 to 1922, inclusive. The base course was entirely pit run sand and gravel concrete, the mix varying from 1:4 to 1:5 according to the gradation of the aggregate. The aggregate was obtained from 14 different pits in the Arkansas River valley in this county. Tamping machines were used



COMBINED BASE AND SURFACE BLOWOUT

Break occurred at a construction joint on one side of which the base remained intact. The rods or dowels in the joint were bent as shown by the blowout.



EXPANSION JOINT AT A BLOWOUT REPAIR

on the base with the exception of the first 6 miles built. The first 30 miles of pavement were constructed without expansion joints, however, the last 8 miles of project 27 completed in 1921-22 were provided with 2-in. poured asphalt joints at the noon and night stops. These averaged about 200 ft. apart, and successfully prevented blowouts on that portion of the work.

In the 30 miles of monolithic brick pavement without joints, blowouts began during the first summer season after construction. They were of three classes: brick surface only, base and brick together, and brick in one place and base in another 10 to 100 ft. away. While the expansion movement at blowouts often measured as much as 2 in., nevertheless, where repairs were made monolithic with the undamaged pavement, temperature failures continued to occur in that vicinity, sometimes within 200 ft. of the repaired portion and once one occurred twice at the same place.

For the past three summer seasons, it has been the practice to place a 3-in. expansion joint in the repair of these failures by turning up the new base to the top of the brick surface on each side of the joint in the form of a concrete curb 8 in. wide. As these joints are wider and much farther apart than the usual constructed expansion joints, it has been found necessary to protect the brick with the curbs to prevent wheel impact and expansion pressure from loosening the brick from the base. The materials, mixes, and method of construction of the rebuilt portion are the same as the original construction with the exception of the curbs, which are made of a 1:2½ mix. Thus, were it not for the expansion joints, it would be difficult after a few months to differentiate in appearance between the old and new portions of the pavement.

The average blowout requires the replacement of about 10 lin.ft. of base and 15 lin.ft. of brick surface. This work is done by two men equipped with a 5-ton truck and such tools as are necessary. Only one side of the pavement at each failure is repaired at a time thereby allowing traffic the use of the other side which, if not already rebuilt, is repaired temporarily for use.

As soon as both sides are completed the expansion joint is poured. This is made of 1 part sawdust and 2 parts of any soft asphalt equivalent to concrete crack filler. We have used this mixture for three years, and find it satisfactory for wide joints. It is soft enough to permit full expansion and does not bleed and run appreciably in summer. Enough joints had been made by last spring so that only five failures occurred in the 30 miles during the summer of 1924.

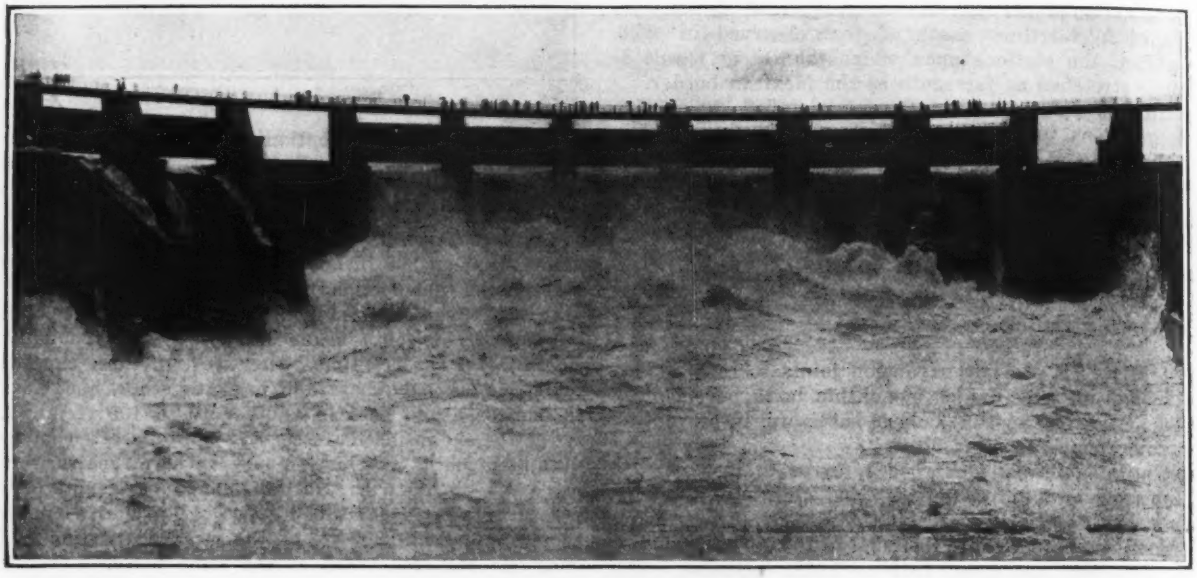
Flood in Panama Canal Zone

Seven Days of Rain Result in a Total Precipitation of 16 Inches—Eight Gates at Gatun Handle the Flood Flow

By R. Z. Kirkpatrick
Chief Hydrographer, Panama Canal

A MEDIUM SIZED flood occurred in the Canal Zone on Nov. 22 to 24, 1924. In the 7 days ending at 8 a.m. Nov. 24 rainfall occurred as shown in the accompanying map. It is seen that the Chagres River watershed was virtually not involved, the 166 sq. miles of Gatun Lake and vicinity receiving most of the rainfall and runoff. With the exception of the great flood of Oct. 16-23, 1923, this was the greatest run of flood water the canal has had since beginning of operation in 1914.

In all over 5.4 billion cu.ft. or approximately 124,000 acre-ft. of water inflow (equivalent to capacity of Tahoe Lake in California and nearly as large as the Croton Lake of New York) occurred between 7 p.m., Nov. 22 and 7 a.m., Nov. 24; and 120 spillway-gate-hours were necessary in spilling this inflow, an amount equivalent to 1.2 ft. on the lake surface. Between 7:10 p.m., Nov. 23 and 8:38 a.m., Nov. 23, there were progressively from 1 to 8 gates spilling water. The 8 gates spilled approximately 87,000 acre-ft. of water from 8:38 a.m., to 7 p.m., Nov. 23. At maximum elevation, during the 8-gate spillage, 100,872 sec.-ft. were going to sea.



GATUN SPILLWAY, PANAMA CANAL
Eight spillway gates discharging over 100,000 sec.-ft. for over 10 hr., Sunday, Nov. 23, 1924. There are 11 gates in all, each capable of discharging 13,000 sec.-ft. at lake elevation + 87.0

RAINFALL MAP, PANAMA CANAL ZONE, NOV. 18-24, 1924

No serious damage resulted from the flood. Shipping went on as usual throughout the whole time, without any delay. A small slide of 3,000 to 4,000 cu.yd. occurred Sunday, Nov. 23, on the Panama R.R. at Milepost 34, delaying one passenger train a few hours. A slide of small area in Gaillard Cut broke loose the next day. Parts of two paved roads were flooded for several hours.

New Telephone Research Company Organized

The research laboratories of the American Telephone and Telegraph Co. and the Western Electric Co., Inc., which were formerly operated as the engineering department of the Western Electric Co., have been consolidated by the formation of a new company, Bell Telephone Laboratories, Inc. This new company, jointly owned by the two companies, has taken over the personnel, buildings and equipment of the previous research laboratories and will greatly extend the work of research activities in the communication and allied fields. The operations of the new laboratories are under the direction of E. B. Craft, executive vice-president, who was formerly chief engineer of the Western Electric Co. Dr. F. B. Jewett, formerly vice-president, Western Electric Co., is president of the new company; E. P. Clifford is vice-president and commercial manager.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

The Lemniscate as a Transition Curve

Sir—*Engineering News-Record* for June 5, 1924, contains an article by Antonio Llano on "The Transition Lemniscate" in which he advocates the use of the lemniscate as a transition curve and draws attention to the fact that it gives a more exact solution of the transition problem than any of the curves in common use for the purpose. The writer published a paper advocating the use of this curve in Vol. 14 of the *Transactions* of the Australian Association for the Advancement of Science, 1913, and subsequently published tables for setting it out by chainage along the curve and angles, just like circular curves. He found that the same curve had previously been prepared by Paul Adams in the *Annales des Ponts et Chaussées*, Oct., 1895.

The form of the complete lemniscate is that of a figure of 8, but only a portion of the complete curve would be used for transition curves, and for this purpose its equation can be most conveniently written in the form

$$r^2 = a^2 \sin 2\theta \qquad (1)$$

In Fig. 1, O denotes the origin of co-ordinates, OPC the curve, and OT, the initial line, is tangent to the curve at O. Then if P is any point on the curve, PT the tangent at P, $OP = r$, angle $POT = \theta$ it is readily proved that

$$\text{angle } OPT = 2\theta \qquad (2)$$

and

$$\text{angle } PTN = 3\theta.$$

If p denotes the radius of curvature at P we have

$$p = \frac{a^2}{3r} \qquad (3)$$

so that p varies inversely as r and the curve is therefore very suitable as a transition curve.

If the curve joins on at the point C to a circular curve of radius R, we have

$$R = \frac{a^2}{3OC} \qquad (4)$$

The length of OC will, as a rule, differ from the length of the transition curve itself by only a fraction of a foot, and we may select for it any suitable value. This equation then determines a^2 when we know R and OC.

Denoting the angle CON by α, we get

$$OC = 3R \sin 2\alpha \qquad (5)$$

There is considerable difference in practice in the length of transition curve adopted on railways. In some cases a fixed length is given to all transition curves. In others the super-elevation of the outer rail is run out by means of the transition curve on a fixed grade. If the latter method, which seems to be the more rational of the two, is adopted, the constant a^2 then becomes the same for all the curves on a given line provided the super-elevation of the outer rail is in all cases that given by the ordinary formula.

For, if e denotes the super-elevation in inches, g the gage in feet, v the maximum train velocity in miles per hour, s the cotangent of the angle of grade at which the super-elevation is to be run out, R the radius of the circular curve in feet,

$$e = \frac{gv^2}{1.25R}$$

and OC (in feet) $= \dfrac{se}{12}$

Therefore,

$$a^2 = 3OC \times R = \frac{sgv^2}{5}$$

a constant depending on the grade, gage and train velocity, and independent of the curve radius.

It thus appears to be good practice and one that lends itself to great simplicity in the preparation of tables and in the necessary calculations to adopt the same value of a throughout any single line of railway. Usually in railway practice there is no special reason why the transition curves should have any precise length. Generally, we may say, the longer they are the better. Some convenient value of a should be selected so that equation (4) will give transition of about the length desired.

In Fig. 2 let OI and $O'I$ be two lengths of straight intersecting at I, the included angle being i. CC' is the circular curve of radius R. OC and $O'C'$ the lemniscate curves at each end. ID bisects the angle at I, D being on the curve.

If a is known, the chords OC and $O'C'$ are found from (4). The angle $IOC = \alpha$ is then determined by (5).

We have also

$$OI = \frac{R}{2} \operatorname{cosec} \frac{i}{2} \left[3 \cos \left(\frac{i}{2} - \alpha \right) - \cos \left(\frac{i}{2} + 3\alpha \right) \right] \qquad (6)$$

and

$$ID = R \operatorname{cosec} i \ (3 \cos \alpha - \cos 3\alpha) - R \qquad (7)$$

Equation (6) enables the point O to be fixed and (7) suffices to mark the point D. Knowing OC and α, the point C can be pegged. Similarly of course with O' and C'. The

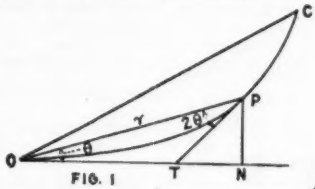


FIG. 1

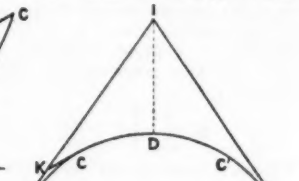


FIG. 2

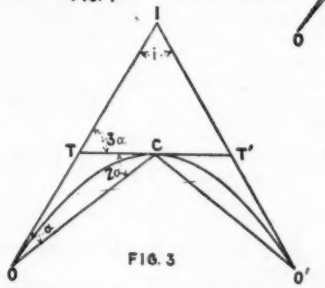


FIG. 3

DETAILS OF THE TRANSITION CURVE

directions of the tangents to the circular curve at C and C' are known, and the circular curve can be set out from either point, with D as a check. CC' subtends an angle at the center of the curve $= 180° - i - 6\alpha$ from which its length may be computed.

Where the ground allows of it the circular curve may be omitted and the entire curve framed of two long transition curves back to back. For such construction, which will give the best attainable smoothness of running, the double lemniscate is particularly suitable, as it can be fitted in between two straights at any angle.

In Fig. 3 let OI and $O'I$ be the two lengths of straight track to be connected, the angle OIO' being i, and let R be the maximum radius of the connecting curve.

Then, as in the figure, if TCT' be the tangent to the double lemniscate curve at its point of maximum curvature C, and the angle IOC be denoted by α we have the angle $ITC = 3\alpha$ and $3\alpha = 90° - \dfrac{i}{2}$, from which α is found.

Also $OC = 3R \sin 2\alpha$ and thus the length of OC is determined.

From the triangle OIC we find

$$OI = 3R \frac{\sin \left(120° - \frac{2i}{3} \right)}{2 \sin \frac{i}{2}}$$

$$IC = 3R \frac{\sin \left(30° - \frac{i}{6} \right) \sin \left(60° - \frac{i}{3} \right)}{\sin \frac{i}{2}}$$

The following table gives the comparative values of *OI* and *IC* for the simple circular curve and the double lemniscate, with different values for i:

i	*OI*		*IC*	
	For Circular Curve	For Double Lemniscate	For Circular Curve	For Double Lemniscate
30°	3.0 *R*	5.7 *R*	2.8 *R*	3.7 *R*
60°	1.7 *R*	2.9 *R*	*R*	1.3 *R*
90°	*R*	1.8 *R*	0.41*R*	0.55*R*
120°	0.57*R*	1.1 *R*	0.15*R*	0.20*R*
150°	0.27*R*	0.58*R*	0.03*R*	0.05*R*

The double lemniscate curve is thus seen to have its crown always considerably further from the intersection point of the straights than a simple circular curve, and its tangent point is much further along.

Instead of a double lemniscate having a minimum radius *R*, it will in general be possible to set out through the same crown tangent point a circular curve with radius greater than *R* and having a transition curve at each end. The double lemniscate construction, however, shows in every case a saving in total length of track, and, in some cases, quite a considerable saving.

The length of the arc *OP* (Fig. 1) can be expressed as the difference of two elliptic integrals. From the properties of these functions it follows that the lemniscate is one of the curves whose arcs, like those of the circle, may be divided in a given ratio by geometrical construction. In the ordinary notation for elliptic integrals the length of the arc *OP*

$$= \frac{a}{\sqrt{2}}\left[F\left(\frac{1}{\sqrt{2}} \times \frac{\pi}{2}\right) - F\left(\frac{1}{\sqrt{2}} \times \phi\right)\right]$$

Where ϕ is an angle such that $\sin 2\theta = \cos^2 \phi$.

Tables of elliptic integrals are available, and with their help it becomes possible to prepare a table of the lengths of arcs of the lemniscate for different values of θ or to find the values of θ corresponding to the division of the curve up into a number of equal lengths. If ϕ_k, ϕ_{k+1}, denote the values ϕ at two consecutive points out of the series dividing the curve into equal arcs, we have

$$F\left(\frac{\pi}{2}\right) - F\left(\phi_{k+1}\right) - \left[F\left(\frac{\pi}{2}\right) - F\left(\phi_k\right)\right] = -F\ (a)$$

$$\text{Therefore, } F\left(\phi_{k+1}\right) - F\left(\phi_k\right) = F\ (a)$$

where a is a constant that may be determined, depending upon the length of the equal arcs.

From this equation it may be proved, from the properties of elliptic functions, that

$$\phi_{k+1} = \tan^{-1}\left[\tan \phi_k \sqrt{(1 - \tfrac{1}{2}\sin^2 a)}\right] - \tan^{-1}\left[\tan a \sqrt{(1 - \tfrac{1}{2}\sin^2 \phi_k)}\right]$$

a formula that may be used to determine ϕ_{k+1} when a and ϕ_k are known. In this way the curve may be divided up into lengths each equal to $\frac{a}{100}$ or to any desired fractional part of a. The values of ϕ having been found the corresponding values of θ are readily computed from the relation $\sin 2\theta = \cos^2 \phi$.

R. W. CHAPMAN.

The University of Adelaide,
Adelaide, South Australia.
Sept. 22, 1924.

Sir—I have read with much interest Prof. Chapman's letter, of which you kindly sent me proof. When I undertook the study of the lemniscate as a transition curve, it was with the object of deriving, if possible, comparatively simple formulas for the deflection angle to any point in terms of length of curve, and conversely; formulas that should apply even beyond the limit up to which that length may be taken equal to the length of the chord. I was fortunate enough to accomplish my purpose. Had I failed, I should not have offered the lemniscate as a practical curve, for, without those formulas, it would be inferior to the Crandall, or Talbot, spiral. Once these formulas are derived, the application of the curve to the solution of the usual problems is a simple matter of elementary geometry and algebra.

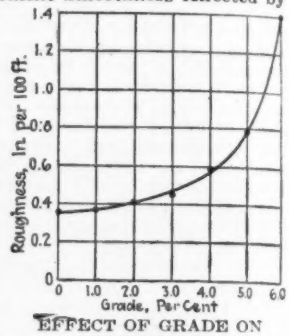
Able and learned as, from the mathematical point of view, Prof. Chapman's treatment undoubtedly is, I fear that, by making the determination of the principal elements depend on formulas involving elliptic integrals, he has given, or would give, the curve a black eye. I think I cured that blemish, and regret to see it again exhibited as a necessary part of the curve's anatomy, making the curve hopelessly repulsive to the practical engineer. To refer the average engineer to his tables of elliptic integrals is about as helpful as to refer him to his Pali edition of the Atharvaveda.

ANTONIO LLANO.

Montclair, N. J., Jan. 6, 1925.

Pavement Smoothness

Sir—In your issue of Jan. 15, 1925, pp. 117 and 118, you published our article on "Pavement Smoothness Affected by Construction Methods." On p. 118 of this article you have published a chart to show the effect of grade on roughness. The original purpose of the chart as submitted was to show that for low percentages of grade the roughness was much less while as the percentage of grade increased the roughness factor increased very rapidly. The curve as published shows a condition exactly the reverse. This was probably occasioned in your drafting room when the chart was copied.



EFFECT OF GRADE ON ROUGHNESS

The chart here shown is the correct one.

H. F. CLEMMER,
Engineer of Materials, Division of Highways,
Illinois Department of Public Works.

Springfield, Ill., Jan. 27, 1925.

Illinois Mountain Roads

Sir—My attention has just been called to an editorial in *Engineering News-Record*, Nov. 6, 1924, p. 734. In discussing mountain highways you went so far as to say that there was not a mile of mountain highway in Illinois. I feel that District 9, to which I am attached, has been slighted.

There are several miles in Illinois which could readily be classed as mountainous. I am best acquainted with the "Ozark" region in southern Illinois. Just south of Carbondale, a car can coast 0.6 mile on Route 2.

I worked on the location of a road along the Ohio River on Route 34 which involved building road on a narrow shelf on the face of a bluff for half a mile, with the railroad about 100 ft. below, and the river below that. However, this line was abandoned for a route three miles inland, where we will have to blast a road out of the face of a bluff at almost maximum grade. In our surveys we are expected to conform to the same policies as to maximum grade, degree of curvature, etc. which are laid down for the flat cornlands you mention. We had to exceed the maximum grade, the steepest I know of being 9.75 per cent. But we adhere closely to the other policies of the department, including the minimum radius of 500 ft.

We have mile on mile of continuous dragline fill; whole sections which average 1,000 cu. yd. of rock to the mile; miles along the valley of a flashy mountain stream of fill on a relatively steep gradient to keep above the sudden rises, and other difficulties peculiar to mountainous country.

The Big Four Ry. has a tunnel down here; the Illinois Central has just started on one, and two other railroads have tunnels under consideration in our district. The St. Louis-Paducah line of the Illinois Central has a maximum grade which I believe to be 99 ft. to the mile. Yet this district, 14 counties, laid 95.6 miles of concrete slab this year.

One of our most delicate problems at some points is to find detours. Our policy is for the state to maintain detours around all work for through traffic. This is difficult where there are no roads except ours for miles in the hills. Anyone familiar with the roads before the state began work, or who has had the misfortune to be detoured near Cobden, New Burnside, Herod, Golconda or Elizabethtown, could easily be convinced that we have a mile of mountainous highway in Illinois.

RUSSELL A. TRUFANT,
Assistant Engineer, Illinois State Highway Department.

Metropolis, Ill.,
Dec. 23, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

"Serve Industry," Theme of McGraw-Hill Convention

Manufacturers' Problems of Distribution Discussed at Meeting of Company Representatives

More effective and economical methods of distribution for the machines and the materials of industry formed the main topic of discussion at the annual sales convention in New York, Jan. 27-30, of the McGraw-Hill Co., Inc., publisher of *Engineering News-Record* and 14 other engineering and industrial journals. Constituting a point of contact between maker and user of equipment, the engineering or industrial publication, it was pointed out, has been an important factor in aiding the solution of many of industry's problems. An expansion of this service was one of the chief aims of the meeting.

After an address by James H. McGraw, president of the company, outlining the purpose of the convention and visualizing an increasing field of usefulness for the business paper, members of the organization listened to W. L. Batt, president, S K F Industries, Inc., on "Creative Selling," and P. L. Thompson, Western Electric Co., on "The Publisher's Representative From a Buyer's Point of View." The remaining sessions of the four-day meeting were given over to papers and discussions by members of the McGraw-Hill organization on market determination methods and analysis of the sales problems of machinery and material manufacturers.

The convention concluded with a banquet at the Pennsylvania Hotel, on the evening of Jan. 30, at which E. J. Mehren, vice-president of the company, presided as toastmaster. The principal speakers were Julius Barnes, past-president of the United States Chamber of Commerce; Fred I. Kent, vice-president, Bankers Trust Co., New York; David Sarnoff, vice-president, Radio Corporation of America and Malcolm Muir, vice-president McGraw-Hill Co. Herbert Hoover, Secretary of Commerce, who had been expected as one of the speakers, sent to Mr. McGraw the message which is reprinted on the contents page of this issue.

About 300 members and guests of the organization were present.

Union Pacific to Build More Double Track in Utah

The double tracking of the remaining 27.4 miles of single track between Omaha and Salt Lake City on the Union Pacific will probably be included in the Union Pacific budget for 1925 according to a statement made by the president of the road in Salt Lake City recently. The uncompleted portion is between Echo and Gateway, Utah, and is largely in Weber Canyon.

Engineering Fifty Years Ago

From *Engineering News*, February, 1875

ENGINEERING is the only one of the professions which directly adds to the wealth of man. Except it be the lawyers, no body of men can ever grow rich by going to law; and none by taking physic can become better than nature made them, and certainly not richer than they were before. The main end of Engineering, however, is increased production and lessened labor; and this is but another mode of saying the practice of engineering is the creation of wealth.

National Board of Public Works Is Proposed

A national board of public works is proposed in a bill which has been introduced by Representative Thomas of Oklahoma. The bill provides that the board is to "have charge of the architecture, engineering, construction, repair and maintenance of all buildings and works built or occupied by or on behalf of the government." The board also is to have authority to purchase all material and perform all other duties necessary in the construction, repair, and maintenance of all such buildings and works.

The board is to consist of three members who will be chosen by the President.

Am. Soc. C. E. Action on Public Works Department Explained

In further explanation of the action taken by the Board of Direction of the American Society of Civil Engineers at its recent meeting in New York as to its position regarding a Department of Public Works, the following paragraphs are offered:

"The Board of Direction of the American Society of Civil Engineers hereby reaffirms its former expressions of approval of the formation of a Department of Public Works in which, so far as possible, all activities of the federal government having to do with engineering and construction shall be grouped.

"This Board also expresses its belief that the best interests of the country will be served by divorcing military and non-military activities and in placing the latter class, where of proper nature, in a Department of Public Works.

"These expressions of the Board of Direction are offered for the guidance of any committees which shall be sent to Congress to represent it in connection with legislation there pending."

Justice Department Drops War Fraud Cases

Vagueness of Indictment Responsible for Dropping Cases Against Crowell and Six Others

Washington Correspondence

Attorney-General Stone on Jan. 30 directed that the appeal from the decision of Justice Hoehling, of the District Court here, rendered one year ago, sustaining the demurrer in the case of the United States vs. Crowell, Starrett, et al, be not prosecuted. The defendants in this case were Morton C. Tuttle, William A. Starrett, Clemens C. Lundoff, Benedict Crowell, Clair Foster, John H. McGibbons and James A. Mears. The indictment was returned by the Federal Grand Jury at Washington, D. C. in December 1922, and was based on the charge of conspiracy to defraud the United States by prejudicing the orderly administration of its laws and regulations by its regularly constituted officers and agents, in connection with administration of war camp construction work.

The defendants demurred on the ground that the allegations of the indictment were so vague, indefinite and uncertain that they did not fully and sufficiently inform the defendants as to the charge they were expected to meet at the trial. Time in which the government had opportunity to perfect an appeal was extended pending determination by the Department of Justice as to whether or not, in view of the decision of Justice Hoehling, an appeal should be taken.

Attorney-General Stone reached the conclusion after a careful examination of all facts in the possession of the government that the case did not state a crime, and, that inasmuch as the indictment was not in such form as to sufficiently advise defendants as to what they were called upon to answer, he felt that, in view of the moral and official duty which rests upon the attorney-general in a case of this kind that the pending appeal should not be prosecuted by the government.

Bids Soon To Be Asked on New Kansas City Water Supply

About Feb. 15 Kansas City, Mo., will begin advertising for bids for a new water-supply system, divided into 14 contracts. There will be a river intake; three pumping stations—river, filter, and high pressure— with motor-driven centrifugal pumps; 15,500 ft. of 7½- and 11,000 ft. of 6½-ft. pressure tunnel; a 17-m.g. equalizing reservoir; 14,000 ft. of 52- and 6,000 ft. of 42-in. steel pipe lines; settling and coagulating basins; and a 100-m.g.d. filtration plant. The work will be done under the direction of the Board of Fire and Water Commissioners.

Bill Appropriates $275,000 for St. Lawrence River Study

Washington Correspondence

Strict compliance with the desire of the Appropriations Committee of the House that all appropriations be preceded by enabling legislation having been insisted upon, Representative Winslow, the chairman of the Committee on Interstate and Foreign Commerce, has introduced a joint resolution authorizing the expenditure of $275,000 for the engineering study of the St. Lawrence River. Since the amount is to be taken from river and harbor funds, no opposition to the proposal is expected.

The President, in a letter to the Speaker of the House, called attention to the fact that the Canadian government already has spent $247,931.26 in engineering studies on the St. Lawrence and has appropriated $150,000 for next season's work. The President states that "much definite information must be obtained to determine the best plan of development and a reliable estimate of its cost. The United States should bear a fair share in bringing the investigation to a conclusion. It is most desirable that we proceed as rapidly as possible to ascertain the cost of the project, the savings of cost that will be effected in transportation of the large quantities of grain and other materials we are moving east from the agricultural sections of our country and of the return cargoes that may be expected, as well as the extent to which it will be profitable to develop power on the St. Lawrence. I recommend that Congress take favorable action upon this request at an early date."

The proposal to expend the $275,000 for borings and other field work in connection with the St. Lawrence project first was carried on the War Department appropriation bill. The appropriations committee insisted on being more circumspect in this instance, than in some others, with the result that the legislative authorization now is before Congress. The American members of the Joint Engineering Commission are particularly anxious to secure the appropriation so that the necessary arrangements can be made and contracts let for the boring which must be done at proposed dam sites.

Sewage Treatment Committee To Study Detroit Situation

A committee of engineers to serve without compensation has been appointed by the mayor to investigate sewage collection, treatment and disposal in Detroit. The committee will report on feasible plans which have roughly been estimated to cost more than $35,000,000.

The committee personnel was picked from a list furnished to the mayor by the engineering societies of Detroit and consists of Albert C. Marshall, vice-president, Detroit Edison Co., chairman; Francis C. McMath, director, Canadian Bridge & Iron Co.; Lewis C. Rogers, chief engineer, Solvay Process Co.; George R. Cooke, engineer and contractor; and Perry A. Fellows, engineer, Frederick A. Stearns Co.

Canadian Institute Re-Elects Dr. Surveyer President

The 39th annual convention of the Engineering Institute of Canada was held at Montreal Jan. 27 and 28. The principal subject of discussion was the overcrowded state of the profession and the need for higher qualifications. The report of the Committee on Apprenticeship and Training emphasized the need of practical experience after graduation and expressed the opinion that the best form of such training as would fit a young man for a responsible position would be to spend two years on the staff of the chief engineer or contractor on large public works with or without pay. This view was endorsed by Secretary Fraser S. Keith, Prof. C. J. Mackenzie, of Saskatchewan University, and others.

Among those who addressed the convention dealing with the relation between the colleges and the profession were Prof. H. M. Mackay of McGill University, Montreal and W. M. Cruthers, of Peterborough, Ont. Gen. C. H. Mitchell of Toronto University urged that as the colleges were supplying the demand of the industries for trained men employers should give reasonable assurances of promotion to graduates in their service.

The report of the Committee on International Co-Operation, presented by J. B. Challies, expressed the hope that an arrangement might be effected for an exchange of privileges between the Institute and societies in the United States. The present membership of the Institute was given as 5,125, with 101 elections pending.

Officers were elected as follows: President (re-elected) Dr. Arthur Surveyer, Montreal; vice-president of Zone A, G. S. Dawson, Calgary, Alta.; vice-president of Zone C, K. B. Thornton.

Engineer Committee Appointed on Detroit Sewage Problem

A committee of five engineers to study and plan a sewage-disposal system for the city of Detroit, Mich., has been announced by Mayor John W. Smith. The members are: Chairman, A. C. Marshall, vice-president Detroit Edison Co.; F. C. McMath, director, Canadian Bridge Co.; George R. Cooke, engineer and contractor; L. C. Rogers, power engineer, Solvay Process Co.; and P. A. Fellows, mechanical superintendent, Frederick A. Stearns Co.

The chairman of the commission has been given authority to proceed according to the best judgment of the commission and has been empowered to call on any of the various city departments for information desired in making the proposed plans. Before the appointments were made the mayor asked for suggestions from the Associated Technical Societies, the Detroit sections of the civil, mechanical and electrical engineers and the Detroit Engineering Society.

Two Minnesota Engineer Societies Hold Concurrent Sessions

The thirteenth annual convention of the Minnesota Surveyors' and Engineers' Society was held in Minneapolis Jan. 22 and 23. The meeting was held concurrently with the fourth annual convention of the Minnesota Federation of Architectural and Engineering Societies.

The convention work of the first named society was carried on largely through the four sectional meetings—highway, municipal, drainage and surveying. Some of the outstanding subjects discussed were: "The Bureau of Public Roads and Its Relation to State and County Highway Development," led by E. O. Hathaway, St. Paul, district engineer, U. S. Bureau of Public Roads; "Motor Bus Transportation," led by Edgar F. Zelle, president, Minnesota Motor Bus Association; "The Location of Trunk Highways Through Cities," led by D. W. Webster of the Minnesota State Highway Department; "The New Sewage System of Austin, Minn.," by Phil Smith, city engineer; and "Rainfall and Runoff in Relation to Drainage," by W. J. Schlick, drainage engineer, Ames, Iowa.

Officers elected for the ensuing year were: F. H. Curtis, consulting engineer, Fairmount, Minn., president; M. E. Chamberlain, consulting engineer, Montevideo, Minn., vice-president; and E. G. Briggs, secretary and treasurer.

The convention of the Minnesota Federation of Architectural and Engineering Societies was held Jan. 23 and 24. The annual banquet, which was held Saturday evening, was attended also by members of the Minnesota Surveyors' and Engineers' Society.

The program of the federation was marked by the great interest shown in subjects other than technical ones such as: the state tax situation in Minnesota; the iron and steel industry in Minnesota, and its future possibilities; an electric power survey of the state.

Two outstanding papers were read: "Why Contracts Lead to Litigation in Engineering and Architectural Work," by Frederick H. Stinchfield, past president, Hennepin County Bar Association; and "The Broader View of Engineering and Architecture," by Dr. C. A. Prosser, president of Dunwoody Institute.

Prof. W. F. Ryan, electrical engineer, University of Minnesota, was elected president; J. R. Stack of Duluth, 1st vice-president; G. H. Hutchinson, St. Paul, 2nd vice-president; W. H. Tusler, Minneapolis, 3rd vice-president; W. E. King, St. Paul, treasurer; and Miss Katherine Feucht, executive secretary.

To Complete Topographic Map

The Temple Bill, providing for the completion of the topographic map of the United States, was passed by the House of Representatives on Jan. 21. It provides for the gathering of the necessary data over a period of twenty years and authorizes co-operative agreements with states or their subdivisions to expedite the mapping within their borders. The sum of $950,000 has been set aside for the work during the current fiscal year.

Asphyxiated, Four Workmen Fall to Death in Foundation Caisson

Special Correspondence

On Jan. 26 four men were killed by a fall caused by asphyxiation, in the caisson at the American Insurance Union Building in Columbus, Ohio. This building covers a quarter of a square 187½ ft. on each side, and a portion of it will rise to a height of 527 ft. above the street level. It will rest on 44 piers sunk by the pneumatic process to rock about 110 ft. below street level. These piers are about 8 ft. square with a 3-ft. circular shaft constructed in the center.

The accident happened in a shaft of a pier located in the northeast corner of the site. The excavation for this pier had extended to a point 32 ft. below street level and the pier had been constructed from this point to a point about 32 ft. above street level. The workmen were in the shaft removing forms in preparation for the installation of the air lock used in the sinking of the pier. One of the men who was about 20 ft. down from the top of the pier suddenly fell to the bottom, some 40 ft. below. Another man, thinking that the first had slipped on the ladder, started after him and he too was overcome and fell to the bottom. The other two men followed in a like manner, attempting to rescue the others, and they, also, dropped and were killed. Realizing that it was probably a case of asphyxiation, air was pumped into the shaft and a man sent down to remove the four who were found to be dead.

An investigation of a similar pier, adjacent to the one on which the accident occurred, disclosed the fact that oxygen in the air had been reduced to such an extent as to make life impossible, the theory being that some matter in the soil had absorbed the oxygen. Tests were made on all the piers since the accident, and it is noted that this occurred on only one small section.

Elevated Highway Over West Side Tracks in New York Proposed

A modification of a plan for the elevation of the New York Central tracks along the west side of Manhattan Island to include a motor highway above the track from Canal St. to 72d St has been announced by the borough president of Manhattan. This latest proposal takes the west side improvement plan submitted to the Transit Commission by the New York Central in 1923 (*Engineering News-Record*, Nov. 29, 1923, p. 906; Dec. 6, 1923, p. 947) as a basis and adds to it an elevated roadway as a roof over the elevated railway tracks. The roadway is to be 32 ft. wide from Canal St. to 30th St. where the railroad is double tracked and 56 ft. wide above 30th St. where the railroad is four tracked. Ramps are to be built at Canal St. for connection to the vehicular tunnels under the Hudson River, and at important cross streets uptown.

The report that the New York Central Railroad Co. has offered to build this roadway in exchange for property easements and right-of-way has not been confirmed.

New Jersey Rapid Transit Report Endorses Loop Plan

The North Jersey Transit Commission, in its first report to the state legislature, endorses the plan proposed by Daniel L. Turner in his report on "The Suburban Transit Problem of New York City" (*Engineering News-Record*, May 8, 1924, p. 818) for a rapid-transit loop running south along the back of the hills which parallel the New Jersey water front at New York to a point opposite the lower end of Manhattan Island and having connections with the suburban lines in New Jersey, thence by tunnel under the river to New York to connections with the existing subways or to connect with a new subway running north to 59th St., and thence by tunnel or bridge across the river to the starting point. The committee states that its studies are not far enough advanced for it to make any definite proposals but that the plan outlined above, used in connection with a larger loop line in New Jersey for intercity traffic in New Jersey, seems to be the most desirable of the numerous plans which have been proposed.

The commission has made a suburban traffic count in New Jersey to determine the origin, route, and destination of each commuter. When the results of this count have been tabulated the commission feels that it will have an accurate picture of the present route of each passenger upon which to base its plan for better and more direct routing. These figures are not yet available but will be published in the near future in this journal.

Commissions to Study Taxing of New York Port Authority

The New Jersey Legislature has passed an act providing for a commission to confer with a similar commission, for creation of which legislation is now pending in the New York Legislature, on the subject of taxing property which may be acquired by the Port of New York Authority. As the Port District includes part or all of 185 different municipalities, as the release of important pieces of property from taxation might work an injustice to such municipalities, and as other property such as the bridges which the Port Authority has been authorized to build are normally public property free from taxation, the Port Authority has requested that the matter of taxing its property be studied and legislation enacted if necessary.

Interchange of Freight Between Railway and Canal Ordered

The Interstate Commerce Commission has ruled that, on and after May 1, 1925, the New York Central R.R. must interchange freight with the New York State Barge Canal at Buffalo. Heretofore the railroad company has taken the attitude that the Barge Canal was not entitled to be treated as a connecting railroad in the matter of arranging for the receipt and interchange of freight.

N. Y. Chapter of A.A.E. Decries Action of Directors

Disapproval of the action of the board of directors in accepting the resignation of Harold Almert, president, to accept the managing directorship, is voiced in a resolution passed by the New York Chapter of the American Association of Engineers at its meeting Jan. 27. The resolution is:

"WHEREAS, the National Board of Directors of the American Association of Engineers, did, on Jan. 9 and 10, 1925, in meeting assembled at Chicago, as detailed in Items 42, 43 and 45 of the minutes of that meeting, create the position of managing director of the association, and did thereupon accept the resignation of the president of the association and did then appoint him to the position of managing director of the association at a salary of $1,000 per month, and

"WHEREAS, even if within the constitutional rights of the board of directors, under the provisions of the constitution and by-laws, such actions are a virtual and moral evasion of the intent of the said constitution and by-laws, and

"WHEREAS, such actions are deemed by the board of directors of the New York Chapter of the American Association of Engineers to be unethical, unjustified, unwise, and inimical to the best interests of the association; now, therefore,

"BE IT RESOLVED, that the several actions of the national board of directors as detailed above, be, and they are hereby disapproved, and

"BE IT FURTHER RESOLVED, that the secretary of the New York Chapter be directed to send copies of this resolution to the president of each chapter of the association, to all national officers and directors, to the former president and now managing director of the association, Harold Almert, and to the technical press, and

"BE IT FURTHER RESOLVED, that the vice-president, now acting as executive officer of the association, be requested to submit the case to the practice committee of the association."

Construction Started on Railway in Lower California

Grading has been started on a new railway from Mexicali on the international boundary in Lower California, to extend, eventually, to San Felipe Bay on the Gulf of California in the same state, a distance of 140 miles. The railway is being built by the Mexicali & Gulf R.R. (Ferrocarril de Mexicali al Golfo), a subsidiary of the Colorado River Land and Improvement Co., which has taken over the concession of National Rys. of Mexico (Ferrocarril Nacionales de Baja California). The present construction will extend as far as La Bomba on the Colorado River. There will be no sharp curves and grades will not exceed 0.5 per cent. The work is in charge of W. I. Bassett, chief engineer and general manager, formerly chief locating engineer for the Southern Pacific R.R. Co. of Mexico.

Washington Section of Am. Soc. C. E. Asks to Join A. E. C.

Formal permission of the American Society of Civil Engineers has been asked by the Washington section of the society to join American Engineering Council. The resolution embodying the section's request was presented to the board of Direction of the society Jan. 20, and the matter was referred to the committee on local sections, consisting of G. H Fenkell, A. O. Ridgway and H. D Dewell. This committee will report at the next Board of Direction meeting, to be held April 20 in Cincinnati.

Some of Dr. Mead's Reclamation Policies Are Opposed

Marked opposition to certain policies of Dr. Elwood Mead, the Commissioner of Reclamation, became manifest during the course of the irrigation conference held recently in Denver. It is stated that half of those present seemed to be more interested in securing the settlement of private rather than public debts.

It was apparent that the point made in Dr. Mead's message to the conference that the Bureau of Reclamation is not a credit agency as are the Farm Loan Board and the War Finance Corporation, was far from popular. The same can be said for his opposition to blanket relief and his advocacy of confining relief to individual cases of settlers on the soil. It was evident that this did not meet with the approval of certain bankers who hold private obligations of water users, or of the speculators who have land holdings on the projects.

Among the things sought by the conference is relief from 1924 operation and maintenance charges. In this connection it is pointed out that the majority sentiment in Congress very evidently is that there is no sound basis for further development if it is impossible to collect operation and maintenance charges. Under such circumstances the tendency among federal legislators is to quit building works.

The feeling is that the same standards sholud apply in the payment for services in connection with irrigation works as are required in the payment of taxes.

St. Louis Lets $1,800,000 Contract for Steel Pipe Line

A contract for furnishing and laying 83,000 lin. ft. of 60-in. and 3,000 ft. of 48-in. steel water pipe has been let by the city of St. Louis, Mo., to Bill Hayes, Inc., Detroit, Michigan, who was the lowest of ten bidders on Jan. 13. The work includes 200,000 cu.yd. of earth excavation, 1,500 cu.yd. of concrete, and gates, blowoffs and air valves. The pipe will be made up by James McNeil & Brother Co., Pittsburgh from some 17,000 tons of Carnegie steel plates. The contract price is $1,800,495.

E. E. Wall is water commissioner of St. Louis.

Patent Suit Fails to Halt Work on Seattle Bridge

Construction work on the Montlake Stadium Bridge, Seattle, will not be interrupted by the efforts of the Strauss Bascule Bridge Co., Chicago, to prove the design an infringement on the Strauss patent. Grave judicial doubt as to such violation is indicated in an opinion given by Judge Jeremiah Neterer who has denied the company a preliminary injunction, ruling that the inconvenience to the public greatly outweighed any damage that could result to the plaintiff should it be found patents had been infringed.

Three years ago, charging similar infringement on the Fifteenth Avenue Northwest, Fremont and University Bridges, the Strauss Co. sued the city for approximately $300,000. Although that case was compromised for around $45,000, Judge Neterer held that such compromise "does not mitigate against denial of patent infringement in this case."

U. S. Retains Civil Consultants To Report on Chicago Drainage

Major Rufus W. Putnam, district engineer of the Corps of Engineers at Chicago, has retained Alvord, Burdick & Howson as consultants in connection with studies he is making of the Chicago Drainage Canal. The services of specialists are considered necessary, because the War Department must check data submitted on the sanitary phases of the diversion problem. In addition, it is expected that the data in possession of this firm will expedite the study now being made in response to the following resolution:

"Resolved, by the Committee on Rivers and Harbors of the House of Representatives, That the Board of Engineers for Rivers and Harbors created under section 3 of the river and harbor act approved June 13, 1902, be, and it hereby is requested to review the reports submitted in House Documents numbered 1374, 61st Congress, 3d session, and 50, 61st Congress, 1st session, and in Rivers and Harbors Committee Documents numbered 2, 67th Congress, 1st session, and 7, 67th Congress, 2d session, with a view to ascertaining and reporting the costs of constructing channels each 200 ft. wide, and of seven, eight and nine feet in depth, respectively, in the Illinois River, Illinois, between Utica and the mouth, including separate estimates for each of the aforesaid channels upon the basis of assumed diversions of water from Lake Michigan through the Illinois River of 2,000, 4,167, 7,500, 8,500, and 10,000 sec.-ft., respectively; also with a view to recommending such depth and width of channel in said river which would be most suitable for navigation purposes, the quantity of diversion from Lake Michigan necessary for navigation purposes in said recommended channel; and to report when, assuming all funds for such purpose available, the Sanitary District of Chicago can have in operation sewage treatment plants capable of treating the sewage with the amount of water recommended as necessary for navigation in such recommended channel."

Random Lines

Numbers 150 to 154

(150) *Soft-Floor Engineers* — The Gardner-Payne Co., Los Angeles, Calif., "one of the finest and best equipped organizations in America for the sale and installation of soft floors."

(151) *Wedding Engineer* — Mr. (or perhaps Miss) Duane Lyon, of the Duane Lyon Studios, of Kansas City, who "originated and attended to all details of the church decorations" when Miss Mary Bryant Schutz was married to Mr. George Moore Browning, at Kansas City the other day.

(152) *Laboratory Furniture Engineers* — the Kewaunee Mfg. Co., of Kewaunee, Wis.

(153) *Package Engineers* — Some forty of the employees of the Hinde & Douch Paper Co., of Sandusky, Ohio, who are "seeking opportunities to render package service." There is no information given as to the price per case or whether the packages are delivered unmarked.

(154) *Horse Engineer* — A story in the *Saturday Evening Post* which says "a circus driver is a sort of graduate from the ordinary rank, a 'horse engineer'" in a way.

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Unsung Prophets

An engineer of international reputation is a man whose articles are read in foreign countries, but whose neighbors are not positive as to whether he drives a locomotive or tunes pianos for a living.—The Cincinnati Engineers' Club Bulletin.

* * *

Treatise on Rubber

By ELLDEE

We cannot give a good excuse why rubber first came into use; but came it did, the same as scales and slide rules, beans and coffin nails. The trusty old hot water sack we gently ease against our back, when it aches clear up to our gourd from bending o'er a drawing board all thru the weary, dreary day—is made of rubber, so they say. But some we've had that sprung a leak and cooked our wishbone or our beak, if analyzed would test more punk than rubber to the cubic chunk. The inner tube, that hoop of wurst, that is so often roundly cursed, is made of rubber too, 'tis said; which makes us dizzy in the head. We had a guaranteed one shoot and ditch us once and skin our snoot. It must have been evolved from tripe doped up with rubber not quite ripe. With one exception rubber things, so called, from boots to teething rings, are half of no percentum bunk—like new false teeth and other junk. The one exception to the rule—and all who languish on a stool with itching legs and tangled feet and draw and add to make ends meet, will bear us out in this we think—is that dingswabbled hinkeydink known as ERASER—"Rub it out!—You'd give a man the painter's gout!" It must be rubber—that or steel; at least that is the way we feel, for we make use of it the most. And it stands up like buttered toast!

Cable Wire Spinning Completed on Philadelphia-Camden Bridge

The last wires for the main cables of the Delaware River Bridge connecting Philadelphia and Camden were put in place on Monday, Jan. 23, and the cables are now complete ready for the placing of the cable bands and the wrapping of the cables. The bridge has two main cables, each of a finished diameter of 30 in. and each containing 18,666 individual wires. Stringing of the cable wires was started in August, 1924 and has been completed within five months. This is believed to establish a new record for this class of work.

Over 50 of the cable bands have been completely machined and are ready for erection, and about 80 per cent of the suspender rope has been manufactured. This rope, part of which is used for support of the timber footbridges, will be cut to length and erected during the next two months, and it is expected that erection of the main span steelwork will be commenced in the early Spring. Fabrication of the main span stiffening trusses has been under way for several months. Two solid trainloads of sixty cars each have already been shipped and the steel placed in storage in Philadelphia, and additional shipments of smaller volume have been made.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 24-27, 1925.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 10-12, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Cincinnati, April 22-24, 1925.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Louisville, Ky., April 27 to May 2, 1925.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Orlando, Fla., June 2-5, 1925.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 22-26, 1925.

The Northwest Branch of the Associated General Contractors of America will hold its annual convention in St. Paul, Feb. 25-27. An original date of Feb. 3-5 had been selected, but on canvassing the membership it was found that a number of officers and members would be out of the territory and other contractors would be away on winter vacations.

The New York Chapter of the American Association of Engineers announces for Feb. 10 a program in charge of the rapid-transit section, the feature of which will be a talk, illustrated with lantern slides, on the Bear Mountain Bridge, by Howard C. Baird, of New York City, consulting engineer on design of the bridge.

The Northeastern Section of the American Society of Civil Engineers held its annual meeting Jan. 31 in Boston. O. C. Merrill, executive secretary of the Federal Power Commission, Washington, D. C., gave an interesting address regarding the need of river studies and surveys to make possible more comprehensive developments on major streams in the combined interests of power, navigation and flood control. Officers were elected for 1925: Charles L. Hammond, president; Edward H. Cameron, vice-president, Charles W. Banks, secretary-treasurer.

The Association of Canadian Building and Construction Industries held its annual convention at Montreal Jan. 28-29. Among the addresses was one by W. J. Black, director of colonization and development, Canadian National Rys., and there were discussions on construction costs and Canada's construction program and the scarcity of apprentices in the skilled trades. On the second day of the convention a joint meeting was held with the Engineering Institute of Canada at which the discussion was on an all-the-year construction program for Canada.

Personal Notes

WILLIAM TOXEY has been elected county engineer of Tuscaloosa County, Alabama, the county in which Tuscaloosa is county seat.

RICHARD BROOKS, previously division engineer of the Charleston division of the Baltimore & Ohio Ry., Eastern Lines, maintenance-of-way department, with headquarters at Weston, W. Va., has been promoted to division engineer of the Wheeling division, vice A. M. Woerner, transferred to Western Lines of the railway. Mr. Brooks has been in the service of the railway since 1909, except for service during the war as major with the 15th Engineers; he is a graduate of the Virginia Military Institute. In the same railway's maintenance-of-way department, J. L. MAHER has been promoted from assistant engineer, Pittsburgh division, headquarters at Pittsburgh, Pa., to the place as division engineer of the Charleston division; Mr. Maher has been in the railway's service since 1906 and served overseas with the 33rd Engineers as captain. G. B. FARLOW has been promoted from assistant division engineer, Cincinnati terminals, to assistant engineer of the Pittsburgh division.

SAMUEL G. LANCASTER, consulting engineer, who supervised the construction of the Columbia River Highway in Oregon and who most recently has been in charge of the rehabilitation of the water supply plant at Jackson, Tenn., has accepted the position of development engineer for the Gulf, Mobile & Northern R.R., and will have headquarters in Mobile, Ala. Twenty years ago Mr. Lancaster was for several years city engineer of Jackson, Tenn., and prior to that was engaged on construction work for the Illinois Central R.R. and for the Gulf, Colorado & Western system.

L. B. FUGITT, superintendent of construction for the John Griffiths & Son Co., on the activated-sludge plant of the Chicago Sanitary District, who was formerly with the Southern Ry., Missouri Pacific Ry. and Kansas City Bridge Co., has become the senior member of the FUGITT-GRACE CO., a new contracting firm specializing in highway and railway bridge work and industrial building. William Grace was formerly vice-president of the William Grace Co., and with the E. B. Johnson Co. and E. W. Sprout Co., contractors. The address of the Fugitt-Grace Co. is 30 La Salle St., Chicago.

D. L. SIMMONS has been appointed chief engineer of the Canadian Board of Railway Commissioners to fill the vacancy caused by the retirement of G. A. Mountain. H. A. K. DRURY, recently divisional engineer of the board at Winnipeg, has been appointed assistant chief engineer, with headquarters at Ottawa.

FRANK M. TOWNSEND, formerly resident engineer on the Tepica—La Quemada line of the Southern Pacific R.R. of Mexico, is now employed on the Mexicali & Gulf R.R., as resident engineer.

KENNETH B. THORNTON, consulting engineer of the Montreal Tramways Co., has been appointed assistant general manager, a new office made necessary by the increase of work of the company. D. E. BLAIR, former superintendent of rolling stock, is appointed general superintendent.

W. S. J. WICK announces that his company, W. S. J. Wick Co., Inc., has established offices at 21 Broadway, New York City, as engineers and architects specializing in the design, construction and supervision of apartment buildings, lofts, mercantile buildings, warehouses and manufacturing plants.

WILLIAM CHISHOLM, formerly provincial minister of highways in Nova Scotia, has been appointed minister of public works for Nova Scotia; and A. S. MACMILLAN, formerly chairman of the Nova Scotia Highways Board, has been appointed to the post of provincial minister of highways.

H. W. CLARK, chief chemist of the Massachusetts State Department of Public Health and director of the Lawrence, Mass., Experiment Station, has been appointed lecturer on sanitary engineering in Harvard University for the remainder of the college year.

WINSTON H. SMITH has resigned as assistant state highway engineer of New Mexico, and R. L. COOPER has been appointed in his place. Mr. Cooper had been district highway engineer in charge of the Albuquerque district for the past two years.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

The Evolution of Highway Construction and Maintenance Equipment—II

By O. L. Kipp
Construction Engineer, Minnesota Highway Department, St. Paul

Second and concluding part of paper presented at the annual meeting of the American Road Builders' Association, Jan. 5-9, Chicago. Maintenance equipment is discussed in Part II, below; construction equipment was the subject of Part I, published in the issue of Jan. 29.

Maintenance

THE increased travel on the public highways, following the widespread use of the motor vehicle, and the adoption of federal-aid laws requiring the maintenance of the Federal-Aid System, have resulted in definite though varied systems of road maintenance and a marked development during the last ten years in equipment adapted to highway maintenance. As a large percentage of the mileage has not yet been paved the work of surface maintenance has been chiefly concerned with earth and gravel surfaced roads.

Early Drags—Prior to 1914 maintenance equipment consisted chiefly of wood or steel counterparts of the original split-log drag. Slight modifications had been made to provide for the tilting of the blades of these drags and some development was being made toward adapting such drags to tractor equipment. In addition to the drags light horse-drawn blade machines were used, but these were designed mainly for four or more horses and the present development in the lighter patrol type of blade graders had hardly yet started.

With the establishment of definite maintenance systems during the past decade we have witnessed to a general extent the passing of the old log drags and even the heavier steel drags have been superseded largely by other equipment, especially on gravel road maintenance. It is still conceded that the road drag can be used to good advantage on dirt roads if employed at the proper time and under favorable conditions, but its use on graveled roads has been quite generally discouraged.

Patrol Graders and Planers

THE development of maintenance on a continuous or full-time basis has given rise to the team patrol organizations. The need for patrol graders resulted in a very considerable volume of business in this particular line of equipment. The early patrol graders were light machines weighing from 700 to 850 lb., but these were found to be less satisfactory than the heavy patrol graders weighing from 1,100 to 1,300 lb. The strengthening of the machine and its increase in weight has been accompanied by the use of longer moldboards and cutting edges. This is especially true on gravelled road maintenance where the team patrol grader is now generally designed for use of an 8-ft. blade instead of the earlier 6 or 6½-ft. lengths. These graders have been strengthened, especially in the wheels, boxings and other parts subject to wear, as the continuous use of patrolmen on gravel road maintenance showed a need for strength which had not been made apparent by the previous occasional use of these graders before continuous maintenance was initiated. Blade grader machines have also been developed to adapt them as maintenance equipment in conjunction with motor trucks and tractors. These large graders are ordinarily equipped with 10-ft. blades and are mounted on roller-bearing wheels with rubber tires.

Road Planers—In contrast to the gradual discard of the road drag there has occurred a development of the road planer designed primarily to overcome objections made to the use of the drag. Such planers usually consist of an arrangement of transverse multiple blades designed to shave off the high spots and fill the low places in the road surface. These planers have been developed to fit the various types of hauling equipment. The team-drawn sizes are made in 10- to 12-ft. lengths, while planers 16 or 18 ft. long are designed for use in conjunction with trucks, and the 20- to 24-ft. lengths are designed for use with tractors. Recent developments in the design of the planer include provisions for changeability of cutting edge, adjustment of hitch arrangements to permit turning in the minimum space, and devices for raising the heavy planers to permit their being moved over railroad crossings or similar obstructions, or being transported considerable distances where necessary.

Tractors and Trucks

THE early use of power for hauling maintenance equipment consisted merely in transferring farm and steam tractors from the work for which they were designed to the maintenance work. No material progress was made in the use of power equipment for maintenance until the last few years when there began a very rapid development in the use of small tractors. On account of the low cost of operation of these tractors and the increased cost in team operation the team patrolman is rapidly being supplanted, so far as surface maintenance blading is concerned, by the small tractor. Larger tractors, particularly of the caterpillar type, are now being used also to a great extent on heavy maintenance work, such as reshaping of the shoulders and ditches, and scarifying and reshaping of the road surface.

In connection with the small tractor there has been a corresponding development of the blade grader or modifications of the blade grader to permit the tractor to become an integral part of it. Such tractor installations usually involve steering control extensions to permit the operator to observe the working of the machine from the rear. Many of these combinations involve also a double or triple set of blades instead of the single blade ordinarily used for grading work. Many of these machines also provide for scarifying equipment and their increased weight and length of wheel base have contributed materially to the effectiveness of this machine as compared with a team-drawn blade. Rubber tires are being used also on many of these motor patrol machines and this equipment is especially desirable where the machines are used largely on gravel road maintenance.

The use of trucks as power equipment for maintenance operations has been largely without any modifications of the truck. In such cases the trucks are generally used only periodically for dragging operations while they are used mainly in the intervals between dragging for hauling surfacing material and other miscellaneous hauling work. The general tendency is toward the use on this class of work of 2- or 3-ton trucks equipped with pneumatic tires. Certain localities have made a special use of the truck in connection with road surface maintenance by equipping the trucks with a suspended spring-blade attachment placed between the front and rear wheels, but the towing of heavy maintenance equipment is a more common practice.

Where the application of additional surfacing material is necessary the trucks have almost entirely superseded horse-drawn equipment for hauling of such material. The operation of these fleets is practically identical with the method already described under gravel surfacing except htat the fleets

Asphalt Association Elects

At the meeting of the Asphalt Association in Chicago during the Road Show the following officers were elected: President, C. G. Sheffield, New York; vice-president, L. M. Law, New Orleans; treasurer, Herbert Spencer, New York; secretary and general manager, J. E. Pennybacker, New York.

During the meeting two new members were elected, the Mexican Petroleum Corporation, New York, and the Asphalt Association of England. The latter membership is due to the relationships established between the two asphalt associations during Mr. Pennybacker's recent trip to Europe. The Asphalt Association of England has as its president Sir Alfred Warren.

are generally smaller and the loading equipment used in connection with them is smaller and more portable. Small draglines and clamshells mounted on motor trucks have found a very extended use for maintenance purposes in connection with resurfacing operations.

Surface Treatment

THE use of road oils on an extensive scale has developed more adequate storage facilities to insure a continuous supply of oil which is not obtainable directly from tank car shipments. Such installations call for proper pump and heating provisions as well as suitable tank capacities to fit the scope of the work. Oil heaters and distributors have been developed in connection with motor equipment and these have been improved to increase their efficiency in the heating and application of the heaviest oils as well as the lighter grades of bituminous materials.

During the past few years the use of calcium chloride in maintenance has developed to considerable proportions. This has lead to the quite general use of the ordinary lime sower or similar spreading device attached to motor truck. For extended use in this connection it has seemed desirable to strengthen the commercial lime sower, especially as to running gear, and also to increase its capacity with extension boards to provide a larger hopper.

Where a considerable amount of slab repair work involves the breaking up of portions of the existing pavement, extended use has been made of paving breakers operated by compressed air from portable compressors mounted on trucks or trailers.

In order to increase the safety with the increasing traffic the practice of painting a line 4 to 6 in. in width down the center of the pavement has become almost universal. For this purpose equipment has been designed for attaching to light trucks; it consists primarily of a marking wheel, guide and frame and hose connections for the flow and control of paint. The paint is carried in the truck body and flows by gravity to a nozzle above the marking wheel which transfers it to the pavement. When the edge of the pavement is clear so as to permit its use as a guide for the center line marking, considerable mileage can be obtained. Often as much as 20 miles have been painted by one outfit in a day and under such conditions the resulting cost per mile is very low.

Where but short stretches of road are to be marked, machines operated by one man have been devised. These machines use an air compressor mounted on a frame equipped with roller bearings, rubber-tired wheels and a spray brush, the outfit as a whole being readily portable.

Snow Removal Equipment

TEN years ago there was practically no effort made toward snow removal or control on the rural highways. Such efforts as were made by city forces depended almost entirely upon hand shoveling into team-drawn wagons, except for such assistance as was rendered by plows attached to street car equipment.

The wide range of equipment now on the market for snow removal has all been developed within the past decade. The problem of snow removal from rural highways corresponds to a large extent to the problem encountered by the railways in keeping their lines free of snow. However, the power equipment available for the railroads has not been available on rural highways and therefore it has been necessary to develop snow-removal equipment suited to highway power equipment. Early efforts in snow removal involved the use of hand shoveling in the case of heavy drifts and the use of horse-drawn blades where snow was not too deep to permit of such equipment being used. The development of caterpillar tractors has made available larger power units. In connection with power equipment three types of plows have been developed, namely, blade plows, V-plows and rotary plows. Various types of blade plows differ in detail particularly as to length, height and shape of moldboard, but practically all have adjustments to permit changes in the cutting angle and elevation of the blade and usually safety devices have been provided to prevent damage by obstructions which might be encountered. These plows can be attached to trucks as well as tractors and they can be operated successfully where snow conditions are not too severe.

V-shaped plows vary as to length and height of plow wings; a number of the plows of this type have been designed to handle extreme snow fall and drift conditions. In many cases four-wheel drive trucks hitched in tandem are operated in connection with this type of plow at a speed of 20 to 25 miles an hour, and the results obtained compare favorably with similar railway plows. Flaring wings capable of various adjustments as to width and height are also being used in connection with these plows to prevent the formation of side ridges. This feature of snow plow design is still deserving of considerable attention in the design of snow-removal equipment.

Considerable experimental work has been under way during the past few years in the design of rotary plows suitable for use in connection with caterpillar tractors and many of these machines are now on the market. The most effective rotary plows include separate power equipment for the operation of the blades. The success which has already been obtained with this type of equipment justifies the belief that it will have a wide field of usefulness with the growing demand of the public for snow removal on the main trunk highways.

Tractors and trucks adapted for snow-removal work are being equipped with weatherproof cabs for the operators, and electric lighting systems to permit the snow plow equipment being operated continuously night and day, when necessary, in order to keep the road open.

Snow Fences—More and more in connection with the problem of snow removal steps are being taken in the matter of snow drift prevention. As a result the last few years have witnessed the erection of a considerable mileage of snow fences. Owing to the need of setting such fences at some distance from the road proper, the item of portability has been properly considered and as a result the so-called railway type of snow fence is being rapidly superseded by picket fencing, consisting of wooden slats about ½ x 1½-in. spaced 2 in. apart and interwoven securely with a series of double strand wire. Erection is made on wooden or steel posts driven at intervals of about 10 ft. The use of such a fence on carefully selected locations greatly facilitates the work of keeping the roads open continuously and reduces the cost of snow removal.

Miscellaneous Equipment

THE adaptation of small tractors to maintenance purposes has led to the production of mowing machines which can readily be attached to small tractors. Practically all such power mowers are designed with safety devices to prevent damage to the cutter bar as well as the tractor itself.

The development of pneumatic paint spray machines has led to their use in the maintenance of steel bridges instead of the hand method of painting structures. Such machines are also quite frequently equipped with revolving wire brushes for cleaning the steel before the paint is applied. In addition to the economy in this new method there is a decided advantage in the spray method of applying paint over hand brushing as corners and surfaces inaccessible to hand brushing can easily be covered.

In conclusion it will be seen from the foregoing that highway construction and maintenance are using to a constantly increasing degree motor traction and power equipment. This is an epoch of manufactured power and the use of such power is being adapted in an increasing way to construction and maintenance work. As a transformer of energy into useful work man is about the least economical machine in the world, says Richard T. Dana in his Handbook of Construction Equipment. Working at top speed he can average in a working day not more than $\frac{1}{10}$ of one mechanical horse power. It is therefore economical to reduce the accomplishment of human energy to the absolute minimum consistent with due co-ordination on the work. This means the substitution of equipment in place of human labor wherever it is possible to do so. Moreover horsepower developed mechanically is very much cheaper than a horsepower derived from teams guided by drivers. Therefore, wherever the same work can be done by machines that would otherwise be performed by horses, the former is economically preferable. These principles account for the substitution of power equipment for hand and team work which has already been accomplished and point to a still greater development along these lines in the future.

To Study Possibilities of 2½-In. Paving Brick

Manufacturers, at St. Louis Convention, Also Advised of Advantages of Asphalt Filler

AT THE largest annual meeting ever held by the National Paving Brick Manufacturers Association, which convened in St. Louis, Jan. 20-22, steps were taken upon the recommendation of paving engineers who addressed the convention to make a careful study of the possibilities of 2½-in. brick for all street and highway paving designed to accommodate light and medium traffic. Beginning 14 years ago and increasing rapidly in the last five years, there has been a decided tendency in some sections of the country toward a thinner brick on the lighter traffic thoroughfares. Paving engineers pointed out to the manufacturers assembled that vitrified paving brick today is essentially a pavement wearing surface. The gist of their recommendations was that with the change from steel to rubber tired traffic, abrasive wear on all pavement surfaces has been reduced until now it is a negligible factor in most sections of the country.

Three Group Meetings

The convention, after a joint meeting the first day, divided itself into three groups: Owners and executives; field engineers and salesmen; superintendents and operating managers. The general subjects discussed were "Better Construction of Brick Pavements," "Modern Sales Methods," and "Economy in Production."

E W. James, chief of design of the U. S. Bureau of Public Roads, was the principal speaker the first day. He told how federal aid is being administered.

Louis H. Egan, president, Union Electric Light & Power Co., St. Louis, was the principal speaker on the second day of the convention. His was an inspirational address dealing with modern methods of selling a quality product to the public.

It was in the group meeting of field engineers that the recommendation for a survey of the possibilities of the 2½-in. brick originated. It was pointed out to the manufacturers that in those cases where a thinner brick is altogether sufficient, the industry would be doing a distinct public service by saving property owners and taxpayers the extra cost of unnecessarily heavy brick. With 2½-in. brick pavements now in use as old as 14 years, it is the intention of the industry to conduct a survey of these pavements from the angles of design, construction, and durability.

Asphalt Filler Endorsed

Another feature of engineering interest in the convention was the almost unanimous vote in favor of recommending to the manufacturers the elimination of cement grout filler from the specifications of the association. Field engineers insisted that asphalt filler, where the proper grade is specified and the proper application accomplished, is by far the best filler for brick pavements. They just as strongly insisted that the cement grout filler, resulting in a rigid slab rather than a flexible slab, has harmed brick pavements more than heavy traffic.

The National Paving Brick Manufacturers Association at its annual meeting in Pittsburgh in December, 1921, adopted a resolution declaring its preference for asphalt filler for general use, such preferment, however, being without prejudice to any type of filler which might possess peculiar adaptation to special local conditions. No action was taken at the St. Louis meeting on the recommendation of field engineers that the cement grout filler should be removed from the association specifications.

Business Notes

Pawling & Harnischfeger Co., Milwaukee, announces the change of its organization name to the Harnischfeger Corporation. The change of name is not accompanied by any change of management, organization or business policy.

J. R. Draney, formerly sales manager at New York for the U. S. Asphalt Refining Co., announces the establishment of himself to market asphalt and allied products including Bitoslag, Kolmend and Surfacrete, with offices at 90 West St., New York, N. Y. Mr. Draney for many years has been identified with the asphalt industry and is president of the Asphalt Association.

Industrial Plants Corporation, liquidators, appraisers and auctioneers, New York City, have been engaged to liquidate approximately $600,000 worth of road-building machinery, including 30 crawler cranes, road-building machines and concrete mixers manufactured by the Austin Machinery Corporation, Muskegon, Mich. (formerly at Toledo, Ohio). This equipment is now located at the Toledo and Muskegon plants of the company. The liquidation is being conducted by Fred R. Shore, Post Office Box 140, Station C, Toledo, Ohio.

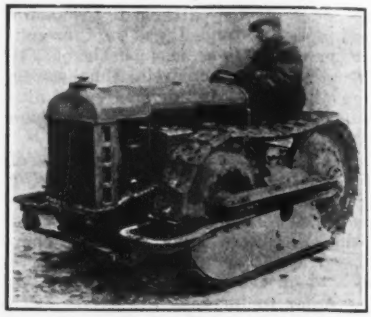
Glenn Grenville Howe, senior vice-president of the Link-Belt Co., Chicago, died at his home in Muskegon, Mich., Dec. 25, after a long illness. His first connection with the organization was as a 16-year-old office boy in 1877. Later he became superintendent of the Ewart Manufacturing Co. When the three related interests, the Ewart company, the Link-Belt Machinery Co. and the Link-Belt Engineering Co., were merged as the Link-Belt Co., in 1906, Mr. Howe became vice-president, in charge of the Indianapolis operations. Under his direction the Belmont malleable iron foundry and Ewart assembly plant were built, in 1913. He organized the Howe Chain Co., at Muskegon, Mich., serving as president of the organization. The sale of the Howe company to the Link-Belt Co. was made in January, 1924, and the Muskegon plant is now operated as the Howe chain plant of the Link-Belt Co., specializing in chain manufacture.

Equipment and Materials

Improved Crawler Attachment for Fordson Tractors

A stronger and more rigid frame, an improved arrangement for track adjustment, and a new type of track guard are features that have been incorporated in the latest model of the Johnson Trackpull, a crawler attachment for Fordson tractors; the Belle City Manufacturing Co., Racine, Wis., recently acquired all rights to the device from the A. C. Johnson Products Co.

The new crawler attachment weighs 2,300 lb. and provides a ground contact of 1,000 sq. in. Through the use of multiple disk clutches, located in the driving sprockets and operating independently, the crawler equipped tractor is claimed to be capable of standing more severe strains than if the regular Fordson differential were used. In addition, the tractor may be turned in its own length. The attachment is equipped with patented treads forming a machine whose general features are indicated in the accompanying photograph.



Details Changed on Grader and Scarifier

On its road graders the Western Wheeled Scraper Co., Aurora, Ill., has recently changed the blade-lifting control from a rack and pinion to a machine cut worm and gear, designed to eliminate lost motion. The device is self-locking in any position, thus doing away with the inconvenience of a brake.

The company's No. 14 scarifier also has been remodeled by placing teeth on both sides of the machine, thus increasing its effectiveness by enabling it to cut either right or left hand. The second row of tool steel teeth, 2½ in. square by 3 ft. 2½ in. long, has been added to tear up common types of hard surfaced roads. The first row of teeth scarify to a depth of 2 in., while the other row can work to depths of 10 to 15 in. The small teeth are used in the same block as the larger teeth, with which they are interchangeable. The teeth are set at an angle of 45 deg. with the line of travel; the first tooth breaks through the road bed and each succeeding tooth chips off a portion from the subgrade.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

January Contracts Justify Expectations Of 1925 Construction Activity

Deducting Single Power Plant Project Worth 52 Millions, Month Is 7½ Per Cent Ahead of January, 1924

Contracts awarded on large engineering construction projects reached a value of $223,980,000 for the month of January, 1925. This represents a gain of 40 per cent over the corresponding period last year. The total for January, 1924 was $159,953,000 and that for January, 1923, $137,678,000.

These totals include no lettings under $10,000 for water-works and excavations; $25,000 for other public work; $40,000 for industrial and $150,000 for commercial buildings.

January contracts averaged $44,796,000 per week as against $35,254,000, during December, 1924.

The January total of $223,980,000 includes a single contract valued at $52,200,000. This job consists of a 460,000 hp. hydro-electric power plant to be erected at Conowingo, Md., awarded to Stone & Webster of New York. The plant is for the Susquehanna Power Co. (Philadelphia Electric Co.) and includes a 3,680 ft. dam, 103 ft. high at spillway section, across the Susquehanna River.

Deducting the value of the Conowingo project from the January total would still leave $171,780,000, a gain of 7½ per cent over the corresponding period in 1924.

January construction was considerably below the month preceding in New England, the Middle West and Canada. It was also under the corresponding period last year in the Middle West, the South and New England. The Canadian lettings were a trifle heavier than for January, 1924.

Engineering News-Record Construction Cost Index Number

February, 1925	**209.70**
January, 1925	210.40
February, 1924	220.30
Peak, June, 1920	273.80
1913	100.00

Jan., 1924	217.90	July, 1924	214.40
Feb.	220.30	Aug.	213.15
Mar.	224.60	Sept.	211.25
Apr.	221.60	Oct.	207.55
May	222.33	Nov.	205.70
June	216.85	Dec.	208.58

Engineering News-Record's Construction Cost Index Number declined 0.7 points since last month, owing to lower rates for unskilled non-union labor. The average rate for common labor is now 54c. per hr., against 55½c. one month ago and 54c. in February, 1924. Thus general construction cost is 5 per cent lower than one year ago and 23 per cent under the peak; it is 109 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

January, 1925	**184**
December, 1924	145
January, 1924	125

Jan., 1924	125	July, 1924	161
Feb.	144	Aug.	162
Mar.	161	Sept.	159
Apr.	159	Oct.	164
May	194	Nov.	128
June	149	Dec.	145

Engineering News-Record's Construction Volume Index Number is 184 for the month of January, and 154 for the whole of 1924, as against 100 for 1913. This means that the actual volume of construction in 1924 (not the mere money-value of the contracts let that year) is 54 per cent above the volume of construction for 1913. Our monthly volume number, 184 for January, 1925, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING JANUARY, 1925

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Canada	Grand Total
Water-works	$186,000	$1,149,000	$250,000	$3,071,000	$336,000	$57,000	$5,049,000	$89,000	$5,138,000
Sewers	189,000	970,000	116,000	603,000	1,537,000	344,000	3,759,000	1,311,000	5,070,000
Bridges	.....	3,055,000	1,219,000	.....	648,000	2,700,000	7,622,000	43,000	7,665,000
Excavation, drainage and irrigation	.....	23,000	165,000	25,000	44,000	215,000	472,000	.....	472,000
Streets and roads	254,000	1,837,000	3,755,000	1,741,000	10,235,000	4,836,000	22,658,000	62,000	22,720,000
Industrial buildings	2,773,000	54,953,000	2,145,000	2,665,000	6,358,000	2,846,000	71,740,000	1,155,000	72,895,000
Commercial buildings	9,393,000	41,393,000	5,781,000	18,219,000	13,964,000	11,920,000	100,670,000	616,000	101,286,000
Federal Government	52,000	312,000	344,000	318,000	197,000	1,401,000	2,624,000	.....	2,624,000
Unclassified	76,000	672,000	2,000,000	704,000	4,254,000	1,680,000	9,386,000	1,585,000	10,971,000
January, 1925	$12,923,000	$104,364,000	$15,775,000	$27,346,000	$37,573,000	$25,999,000	$223,980,000	$4,861,000	$228,841,000
December, 1924	15,661,000	38,267,000	6,300,000	37,681,000	22,649,000	20,458,000	141,016,000	13,747,000	154,763,000
January, 1924	21,667,000	48,285,000	18,267,000	27,979,000	21,273,000	22,482,000	159,953,000	4,769,000	164,722,000

Labor Rates and Conditions Throughout the Country

Aside from the uncertainties still existing in a few of the major industries, such as coal mining, the soundness of existing business conditions is attested by the following ten factors: (1) Increasing iron and steel output; (2) continued improvement in the textile situation; (3) greater activity in the metal working industries; (4) acceleration of the wood-working industries; (5) increased leather production and demand; (6) better returns to the farmer for agricultural products, with commensurate increase in his buying power; (7) automotive plant expansion; (8) excess of exports over imports; (9) construction of more railroad shops and terminals; (10) favorable credit conditions without inflation.

Local conditions as reported to *Engineering News-Record*, follow:

Baltimore — Conditions continue normal in the skilled building trades; unemployment among unskilled workers.

Birmingham—Construction conditions excellent; work more plentiful than in several years. Small surplus of unskilled men.

Boston—Building construction active. Mechanics of all kinds plentiful.

Cincinnati—Surplus of men in construction industry. Wage scale unchanged.

Dallas — Small surplus of building craftsmen.

CURRENT BUILDING TRADES WAGE RATES PER HOUR
(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.75	.90@1.20	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	.35@.75	.75@1.25	+.50@.75	.....	.75@1.25	+.25@.40
Boston	1.25	1.00@1.10	1.25@1.35	—.82½	1.05	1.25	.50@.57
Cincinnati	1.50	1.25	1.25	.92½	1.25	1.25	.55
Chicago	1.50	1.15@1.25	1.10@1.25	1.00	1.25	1.25	.75@.82½
Cleveland	1.50	1.25	1.30	.87½	1.00	1.37½	.87½
Dallas	1.50	1.00	1.00	.40@.75	.87½	1.00	.30@.50
Denver	1.62½	1.12½	1.12½@1.18¾	.81¼@.87½	1.00	1.15¾	.35@.55
Detroit	1.50	.90@1.00	.85@1.00	.90	.85@1.00	1.12½	.60@.75
Kansas City	—1.37½@1.50	1.12½	1.00	+.90	1.00	1.00@1.12½	—.40@.75
Los Angeles	1.00@1.25	—.87½@.100	.75	—.87½@1.12	.87½	+.87½@1.00	.50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	.50@.55
Montreal	—.90	—.45@.65	.62½	—.30@.35	.50	.65	.25@.30
New Orleans	1.25	.90	1.00	.65	.80	1.12½	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00@1.12½	1.31¼	.62½@.75
Philadelphia	1.50	1.12½	1.02½	1.12½	1.00	1.12½	.40@.45
Pittsburgh	1.55	1.37½	1.25@1.37½	1.00	.....	1.37½	.70
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.50	1.50	—.45@.77½
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	1.00	1.00@1.12½	1.12½	.50@.62½

Denver — Building trades craftsmen plentiful, but sufficient work under way to keep all employed during winter. Scarcity of bricklayers.

Detroit—Small surplus of unemployed mechanics. No change in wage schedule.

Kansas City — Labor conditions unsettled. Unskilled common laborers reduced 10c. per hr. from Jan. 1 level.

Minneapolis — Seasonal surplus of building trades mechanics.

Montreal — Unemployment situation is acute. Surplus of unskilled laborers.

New Orleans — Building tradesmen fairly well employed. Construction active.

New York—Unfavorable weather conditions have resulted in a slight surplus of unskilled laborers. This has been added to by migrations from out-of-town points. Skilled men are more in demand. During the past month, wire lathers' foremen went on strike for $75 per week, an advance of $12.75 over the wage rate now in operation.

Philadelphia—Seasonal let-up in construction operations with consequently small amount of unemployment in the building trades.

St. Louis—Building continues active. Despite this fact, unskilled, non-union laborers are obtainable at lower rates than a month ago.

San Francisco—Surplus of men in all crafts due to influx of migratory workers from colder sections of the country.

Monthly Prices of Construction Materials

Ups and Downs of the Market

The cost of construction is a fraction of a per cent below the January level. This is due almost entirely to a slightly lower rate for common labor. Such items as iron, steel, lumber, cement, railroad and paint materials are higher than a month ago. Unskilled common laborers are more plentiful in the Middle West, as a result of unfavorable weather. The consequent wage decline has similarly effected the common labor rate for the nation.

Pig Iron—Market has remained firm despite relatively light demand. Prices are 50c. to $1 per ton higher in Cincinnati, Birmingham and Philadelphia, compared with a month ago. Most of the current buying is confined to charcoal iron.

Railway Supplies—Rail buying is a prominent factor in the present market. The mill price of $43 per ton for standard rails has held firmly during the past year. Track supplies are in good demand with advances reported in spikes and bolts.

Pipe — Steel pipe, in keeping with rails and tin plates, has experienced little or no price change during the past year. C.-i. pipe may be said to be neither advancing nor declining; clay pipe is down.

Road and Paving Materials — An early advance in road oils has started in the Southern and Western sections of the country. Three out of five cities report declines in asphalt.

Sand, Gravel and Crushed Stone—Prices of aggregates have shown little change, throughout the entire country, during the past month. The price at New York docks is 25c. per cu.yd. under the level of a year ago, for ¾- and 1½-in. gravel.

Lime and Cement—Declines in prices of lump lime, ranging from 5 to 25c. per bbl., occurred in New York, Chicago and Boston during the month; other grades stable. Cement is rising. Advances averaging 10c. per bbl. occurred throughout the entire Middle West during the past month. This indicates the beginning of the spring demand for building materials.

Brick and Hollow Tile—There is little fluctuation in brick prices at the present time. None is anticipated until the time draws near for the opening of the Northern yards for spring production. Hollow tile is stable.

Structural Steel—Quotations on heavy rolled products for second quarter delivery are tending upward. Quotations on current shipments are: shapes, $2@$2.10; bars, $2.10@$2.20; and plates, $2@$2.20 per 100 lb., Pittsburgh. These prices are practically the same as last month.

Lumber — While the lumber demand for the entire nation, for the week ended Jan. 24, was smaller than that for the week preceding and under that of a year ago, there is a great excess of advances over declines in current market quotations on all species. This is due to the fact that shipments for replenishment of yard stocks in Northern districts have been delayed by bad weather.

Iron and Steel Scrap—Prices down about $1 per ton from levels of a month ago. This is believed to be a temporary reaction, since steel prices are growing firmer.

Paint Materials — Raw linseed oil jumped about 5c. per gal. in New York and Minneapolis during the past week, owing to higher flaxseed quotations in the Mid-Western markets. Red and white lead rose 1c. per lb. since Jan. 1. This advance is due to higher prices of pig metal.

Prices advance since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Feb. 5	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$24.05	$25.05
Northern Basic	**23.77**	24.00
Southern Ohio No. 2 (silicon 1.75@2.25)	**23.77**	24.00
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	30.25	28.00
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	20.00@**20.50**	23.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	**24.76**	24.25
Virginia No. 2 (silicon 2.25@2.75)	**30.17**	28.17
Basic	**24.76**	24.00
Gray Forge	**23.75**	24.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	22.00	24.50
No. 2 Foundry Southern (silicon 2.25@2.75)	25.55	27.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	23.77	25.77
Basic	23.77	25.77
Bessemer	23.77	26.77

SCRAP—The prices following are f.o.b., per gross ton paid to dealers and producers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	*$15.00*	*$16*@16.50*	$14@**15**
Stove plate	*12.00*	*15.50*@16*	15@**16**
No. 1 machinery cast	*15.00*	19@19.50*	16@17
Machine shop turnings	11.00	12@12.50	8@**9**
Cast borings	11.00	14.75@**15.25**	15@16
Railroad malleable	*14.00*	20@20.50	18@19
Re-rolling rails	*15.00*	**21**@**21.50**	17@**18**
Re-laying rails	*21.00*	*25*@26	26@**27**
Heavy melting steel	*14.00*	**18**@**18.50**	*15*@*15.50*

*Per net ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Feb. 5	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	$46@49
Standard openhearth rails	43.00	43.00	43.00	43.00	*48*@52
Light rails, 8 to 10 lb.	36.00	43@45	*36@38*	1.90@2.00*	
Light rails, 12 to 14 lb.	36.00	43@45	*36@38*	1.90@2.00*	2.05@2.15*
Light rails, 25 to 45 lb.	36.00	43@45	*36@38*	1.90@2.00*	1.95@2.10*
Re-rolled rails	27@**32**	37@40	.....	.....	

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	$1.60	$2.00
Chicago, (creosoted) (zinc treated)	1.70	2.10
San Francisco..... Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted, Douglas Fir	1.70	2.25
St. Louis, White Oak, plain	1.20	1.40
St. Louis (creosoted) (zinc treated)	1.60	1.90
St. Louis, Red Oak, plain	1.10	1.30
St. Louis, Sap pine-cypress	.95	1.15
St. Louis, yellow pine	1.00	1.30
Birmingham, White Oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Feb. 5	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	$2.90	$3.05@3.15	**$3.55**	$3.55	$4.35	**$2.90**
Track bolts	**3.90**@**4.25**	4.00@4.25	**4.55**	4.55	5.85	*3.75* @**4.00**
Standard section angle bars	2.75@**2.85**	2.75	3.30	3.40	4.00	2.85

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	*53%*	59½%	62%	49%
3½ to 6 in. lap welded	*48%*	56½%	59%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	*39%*	48%	50½%	36%
3½ to 6 in. lap welded	*35%*	45%	47%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 36% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Pittsburgh	New York Feb. 5	New York One Year Ago
4 in.	**$50@55**	*$53.20@54.20*	*$59.60@60.60*	$67.10@68.60
6 in. and over	**$48@50**	*49.20@50.20*	*54.60@55.60*	61.60@63.60

	Chicago	St. Louis	San Francisco
4 in.	**$53.20@54.20**	*$52.00*	$57.00
6 in. and over	**49.20@50.20**	*48.00*	53.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Feb. 5	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$48.00	$45.00	$40.00	$45.00	.....	$73.00
4	50.00	55.00	40.00	56.00	$76.50	110.00
5	70.00	80.00	.....	80.00	97.75	118.00
6	92.00	105.00	70.00	*100.00*	127.50	150.00
8	160.00	170.00	170.00	*165.00*	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.09	$0.10	.....	....	$0.12	.....
4	....	.09	.10	$0.10	....	.15	$0.14
5	....	.135	*.135*	.....	....	.18	.18
6	$0.21	.135	*.135*	.14	....	.21	.21
8	.35	.21	*.21*	.225	....	.30	.325
10	.52	.315	*.315*	.315	....	.42	.476
12	.67	.405	.45	.405†	....	.54	.612
15	1.14†	.54	.67	.675†	....	.90	1.02
18	1.65†	.75	*.80*	.945†	....	1.32	1.53
20	1.98†	.90	*.95*	1.26†	....	.....	.....
22	2.65†	1.20	*1.15*	.....	....	.....	1.564
24	2.97†	1.35	*1.35*	1.62†	....	2.16	2.04
27	4.65†	2.665	*2.65*	2.45†	....	3.00	3.34
30	5.16†	2.952	*2.95*	3.00†	....	3.60	4.06
33	6.98†	3.96	*3.95*	3.55†	....	.....	4.99
36	8.00†	4.51	4.55	3.95†	....	.....	5.42

	3	5	8	12	24	36
Boston	$0.13	*$0.20*	$0.35	$0.70	*$2.20*†	*$6.00*†
Minneapolis	.....	.....	.40	.72	2.55†	5.66†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.72†	2.60†	.....
Los Angeles	.1625	.195	.275	.495	1.65	.....
New Orleans	*.115**	.177*	.295	**.5015**	**1.9175**	.....
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	0.93	.1395	.217	.4185	2.115†	5.535†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo	.15*	.21*	.335	.52†	2.09†	**4.35**†
Philadelphia	.12	.18	.28	.54	1.80	4.61

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Feb. 5	One Year Ago
New York, 45% asphalt	(at terminal)	**$0.07**	**$0.053**
New York, 65% asphalt	(at terminal)	.07½	.051
New York, binder	(at terminal)	.07½	.06
New York, flux	(at terminal)	.075	.06
New York, liquid asphalt	(at terminal)	.075	.048
St. Louis, 40@50% asphalt		**.0532**	.0575
St. Louis, 50@60% asphalt		**.0597**	.06
Birmingham, 45% asphalt		.....	.....
Birmingham, 55% asphalt		**.0475**	.....
Dallas, 45% asphalt		.0495	.0495
Dallas, 55% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		**12.60***	9.50*

*F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$23.00*	$18.00
Boston (*Mexican*)	21.00	16.00
Chicago (*Stanolind*)	21.00	15.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	22.25	20.50
Denver (*California*)	24.00	....
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	25.10	19.10
St. Louis (*Mexican*)	*25.00*	*21.00*
Baltimore (*Mexican*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	32.00	28.50
Detroit (*Mexican*)	22.00	18.00
Cincinnati (*Kentucky Rock*)	....	11.65
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	20.50	17.50
Philadelphia (*Mexican*)	22.00	17.00
Kansas City (*Texas*)	27.30	*22.30*
Los Angeles (*"D" grade, California*)	19.10	12.00†
Birmingham (*Mexican*)	*27.00*	*21.00*
New Orleans (*Mexican*)	23.00	17.00

*In drums. †f.o.b. El Segundo Refinery.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$135.00@142.00 per M.
Chicago	About 4x8x4 dressed	per sq.yd.
	About 4x8x4 common	per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	*130.00* per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	3.25 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	4x8x4	1.65 per sq.yd.
Kansas City	Granite	4.00 per sq.yd.
Philadelphia	Granite	3.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.20 per lin.ft.
Chicago	18 in. wide	.... per lin.ft.

CURBING—*New York:* Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 85c.; 5x20 in., Queens, 90c. *St. Louis:* Class "A" straight, delivered, 5x18 in., $1.00 per lin.ft.; roundings, $1.50.

WOOD BLOCK PAVING—	Size of Block	Treatment	Per Sq.Yd
New York (*delivered*)	3	16	$2.51
New York (*delivered*)	3½	16	2.82
Boston	3½	18	*2.55*
Chicago	4	16	....
Chicago	3½	16	....
St. Louis	3½	16	2.40
St. Louis	4	16	2.70
Seattle	4	16	Off market
Minneapolis	3½	16	2.75
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	....
Cincinnati	3½	16	2.38
Kansas City	4	16	3.95
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Feb. 5	One Year Ago	Feb. 5	One Year Ago	Feb. 5	One Year Ago
New York (*alongside dock*)	*$1.75*	$2.00	*$1.75*	$2.00	$1.25	$1.25
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	3.00	2.00	3.00	2.00	3.00	2.00
St. Louis	1.45	1.40†	1.45	1.50†	1.18	1.20
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.00	2.38	2.00	2.00	2.00
Minneapolis	1.65*	1.85*	1.65*	1.85*	1.25	1.37
Cincinnati	1.40†	1.35†	1.40†	1.35†	1.35†	1.30†
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.50†	1.40†	1.50†	1.40†	1.00†	1.20†
New Orleans	2.63	2.85	2.63	2.85	1.75	1.25
Los Angeles	1.50†	2.50	1.55†	2.50	1.10†	1.75
Atlanta	1.90†	2.00†	1.90†	2.00†	1.40†	1.42†
Detroit	2.02	1.62	2.02	1.62	1.62	2.02
Baltimore	1.40	1.40	1.60	1.60	0.70†	0.70†
Montreal	1.25†	1.25†	1.25†	1.50†	1.25†	1.25†
Birmingham	2.00	....	2.00	....	1.45†	1.30†
Philadelphia	2.10	2.15†	2.10	2.15†	1.50	1.65†
Kansas City	4.00	....	4.00	....	0.66*†0.66*†	

New York—Grits, *$1.75* per cu. yd.; ready mixed, $2.00.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit. † Per ton.

CRUSHED STONE—Price for cargo or carload lots, f.o.b. city, is as follows, per cu.yd.:

	1½ In.		¾ In.	
	Feb. 5	One Year Ago	Feb. 5	One Year Ago
New York	$1.75	$1.75	$1.85	$1.85
Chicago	3.00	2.00	3.00	2.00
St. Louis	1.75*	1.75*	1.75*	1.75*
Dallas	2.40	....	2.83	2.83
San Francisco	2.15	2.15	2.15	2.15
Boston	1.60*	1.50*	1.60*	1.50*
Minneapolis	1.75	1.85	1.75	2.00
Kansas City	1.50	1.50	1.50	1.50
Denver	2.50	3.50	2.50	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.00*	2.00*	2.00*	2.00*
Cincinnati	1.90*	1.70	1.90*	1.70
Los Angeles	1.65*	2.75	1.75*	3.00
Detroit	1.70	1.75	1.70	1.75
Baltimore	2.50	2.50	2.55	2.55
Montreal	2.25*	....	2.25*	....
Philadelphia	2.10	2.15*	2.10	2.15*
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	2.00	....	2.00	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.25	$1.35	$2.00	$1.25
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	....	....	2.50	....
Birmingham, Ala.	1.00	1.20	....	....
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.30	*1.30*	1.30	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.50	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	....
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$12.00@$13.10	*$3.50**	$2.50@*2.75**
Chicago	20.00	....	....	*1.26*†
St. Louis	24.00	*19.00*	....	1.23†
Boston	20.00	15.00	*3.85**	*3.10**
Dallas	20.00	....	....	1.85†
Cincinnati	16.80	14.30	....	13.40‡
San Francisco	22.00	....	....	1.60†
Minneapolis	23.00	21.00 (white)	1.60†	1.35†
Denver	24.00	.....	.....	2.70†
Detroit	16.00	.....	....	17.00‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	....	18.00	....	2.70†
Baltimore	24.25	17.85	2.55†	....
Montreal	....	21.00	....	10.50‡
Atlanta	22.50	14.00	2.10†	1.45†
New Orleans	24.00	17.00	2.00†	2.00†
Philadelphia	23.00	16.00	.....	.....
Kansas City	28.00	24.00	....	....
Birmingham	20.00	15.00	2.10†	1.75†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.80. Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks, lump lime "alongside dealer's dock" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Feb. 5	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.50	1.75
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.50	2.65
St. Louis (Carney)	2.35	2.45
Birmingham (Magnolia) pozzolan cement	2.40	2.10

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Feb. 5	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.50@2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	*2.60*	2.67½	2.63
Chicago	2.20	2.10	2.20
Pittsburgh	2.19	2.19	2.19
Cleveland	2.39	2.39	2.41
Detroit	*2.35*	2.40	2.37
Indianapolis	2.41	2.31	2.31
Milwaukee	2.35	2.25	2.35
Duluth	2.19	2.19	2.19
Peoria	2.27	2.27	2.27
Cedar Rapids	2.44	2.38	2.40
Davenport	2.39	2.29	2.29
St. Louis	2.30	2.20	2.20
San Francisco	2.61	2.61	2.61
New Orleans	2.40	2.40	2.40
Minneapolis	2.42	2.42	2.42
Denver	2.84	2.84	2.84
Seattle	2.65	2.65	2.90
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.35
Cincinnati	2.47	2.37	2.37
Los Angeles	2.80	2.60	3.16
Baltimore	2.90	2.90	2.50
Birmingham	2.40	2.40	2.80
Kansas City	2.30	2.07	2.20
Montreal	1.80	1.80	2.25
Philadelphia	2.41	2.41	2.41
St. Paul	2.42	2.42	2.42
Toledo	2.40	2.36	2.40

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.95	Hudson, N. Y.	$2.05
Universal, Pa.	1.95	Leeds, Ala.	1.95
Steelton, Minn.	2.00	Hannibal, Mo.	2.05
Fordwick, Va.	2.05	Lehigh Valley District	1.95
Mitchell, Ind.	2.05	Wyandotte, Mich.	*2.10*
Iola, Kan.	1.95	Alpena, Mich.	2.00
Mason City, Ia.	2.00	Richard City, Tenn.	2.05
La Salle, Ill.	2.05	Kingsport, Tenn.	2.05

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$0.95	$1.39	$1.04	$1.13	*$1.20*
049	28	1.23	1.20	1.76	1.32	1.38	*1.42*
068	35	1.51	**1.50**	2.16	1.62	1.67	1.87
093	45	1.94	**1.93**	2.77	2.08	2.00	2.40
126	57	2.39	**2.38**	3.45	2.57	2.55	2.97
153	68	2.86	**2.85**	4.11	3.07	3.15	.....
180	78	3.28	**3.28**	5.70	3.52	3.47	.....
245	103	4.33	**4.32**	6.21	4.65	4.58	.....
287	119	5.00	**4.95**	7.19	5.38	5.26	6.23
336	138	5.80	**5.75**	8.35	6.23	6.11	.....
395	160	6.72	**6.70**	9.65	7.22	7.12	.....
PAVING							
036P	17	$0.74	**$0.74**	$1.06	$0.80	$0.76	.....
053P	24	1.04	**1.05**	1.50	1.12	1.07	.....
072P	31	1.32	**1.32**	1.90	1.42	1.39	.....
097P	40	1.70	1.70	2.45	1.83	1.90	.....
049R	24	1.04	1.04	.....	1.12	1.07	.....
067R	31	1.32	1.30	.....	1.42	1.39	.....
089R	40	1.70	1.70	.....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Weight in pounds	New York	Birmingham	St. Louis	San Francisco	Dallas
2.2	*$19.00*	$22.00	$19.00	$24.00	$23.50
2.5	*20.50*	23.00	21.00	26.00	25.00
3.0	*23.50*	26.00	24.50	30.00	28.50
3.4	*25.00*	28.00	26.50	.....	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
¼ and larger..	$2.10@**2.20**	$2.25	$3.24	$3.00	$3.15	$3.38	$3.35
⅜.....	2.20@**2.30**	2.35	3.34	3.10	3.25	3.43	3.45
½.....	2.30@**2.40**	2.45	3.44	3.20	*3.35*	3.48	3.55
⅝.....	2.50@**2.60**	2.65	3.64	3.40	*3.55*	3.63	3.75
¾.....	3.10@**3.20**	3.25	4.24	4.00	*4.15*	3.78	4.35

For size and cutting extras, manufacturers and distributors, see bar card of July 15, 1923.

ROLLED FROM RAILS

	Birmingham	St. Louis	Dallas		Birmingham	St. Louis	Dallas
¼ and larger..	.....	*$2.60**	$3.08	½.....	.....	*$3.00**	$3.30
⅜ in.....	.....	*2.70**	3.13	⅝.....	.....	*3.70**	3.48
½.....	.....	*2.80**	3.18	¾.....	.....	.....	.....

* Warehouse shipments.

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Feb. 5	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.).....	$18.00	$18.00	$23.65@25.85	$45.00	$51.00
New York (at dock)...	15.00	15.00	20@22	.....	.....
Chicago.....	12.00	12.00	11.00	50.00	50.00
St. Louis, salmon.....	16.00	14@16	16@18	.....	40.00
Denver, salmon.....	12.00	12.00	12.00	.....	.....
Dallas.....	11.60	11.60	11.60	35.00	.....
San Francisco.....	**15.50**	14.50	15.50	.....	.....
Los Angeles.....	13.00	13.00	14.50	(not used)	
Boston (del.).....	*19.00*	21.00	22.00	*45.00*	*52.00*
Minneapolis (del.).....	15.00	15.00	16@18	.....	.....
Kansas City.....	14.50	14.50	16.50	(no market)	
Seattle.....	14.50	14.50	15.00	.....	42.50
Cincinnati.....	17.00	17.00	17.00	40.00	45.00
Montreal.....	17.50	17.50	16.50	100.00†	68.00
Detroit (del.).....	17.50	17.50	17.50	38.50	41.50
Baltimore.....	18.00	18.00	21.00	40.00	45.00
Atlanta.....	10.50	10.50	12.00	40.00	.....
New Orleans.....	15.00	15.00	18.75	.....	.....
Birmingham.....	12.50	12.50	12.50@14	40.00	45.00
Philadelphia.....	19.00	19.00	21.00	38.00	46.00
Pittsburgh (del.).....	16.00	16.00	16.00	.....	.....
Cleveland.....	14@16	14@16	16.00	.....	.....

*For paving blocks 3½x8½x3 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Feb. 5 on Trucks*	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12...	$0.1162	$0.1179	$0.06	$0.125	*$0.078*	$0.108	.....
6x12x12...	.1743	.1769	.0825	.....	*.104*	.156	.....
8x12x12...	.2179	.2211	.1125	.215	*.146*	.244	.....
10x12x12...	.....	.....	.14	.....	*.175*	.....	$0.2388
12x12x12...	.....	.....	.18	.....	*.200*	.....	.2956

*5 per cent off for cash.

	4x12x12	8x12x12	12x12x12
Boston.....	*$0.11*	*$0.20*	
Minneapolis (f.o.b. cars).....	.063	.11	$0.195
Minneapolis (delivered).....	.07	.12	.21
Cincinnati.....	.07485	.13745	.....
Kansas City.....	**.086**	**.158**	.....
Denver.....	.085	.155	.188
Seattle (delivered).....	.11	.20	.30
Los Angeles.....	.085	.172	.....
New Orleans.....	.0893	.1674	.....
Detroit (delivered).....	.0815	.1529	.....
Montreal.....	.12	.225	.30
Baltimore.....	.125	.27	.....
Atlanta.....	.1004	.1674	.....
Dallas.....	.0941	.1824	.205
Birmingham.....	.11	.175	.22
Pittsburgh (delivered).....	.068	.128	.179
Cleveland.....	.064	.149	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in....	$2.00@2.10	**$2.05**	$3.34	$4.15	$3.25	$3.10	**$3.15**
Channels, 3 to 15 in.	2.00@2.10	**2.10**	3.34	4.15	3.25	3.10	**3.15**
Angles, 3 to 16 in., ¼ in. thick.....	2.00@2.10	**2.10**	3.34	4.15	3.25	3.10	**3.15**
Tees, 3 in. and larger	2.00@2.10	**2.10**	3.34	4.15	3.25	3.10	**3.15**
Plates, ¼ in. thick and heavier.....	2.00@**2.20**	**2.00**	3.34	4.15	3.25	3.10	**3.15**

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York—Feb. 5	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.....	$2.60	$4.25	$4.40	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.....	$2.90	$4.35	$4.50	$3.70	$3.70	$5.20	$5.00
⅝ and ¾.....	3.05	4.50	4.66	3.80	4.20@4.45	5.35	5.15
⅞ and 1".....	3.30	4.75	4.90	4.05	**4.60**	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire.....	$2.85	*$2.80*	$3.25	$4.00	**$4.50**	*$3.18*	4.95
Cut.....	2.90	*2.95*	....	5.25	5.00	*3.28*	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	Black	Seattle Black
½.....	$8.00	$6.00	$7.75
⅝.....	7.30	5.30	5.40
¾.....	7.15	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.77 per roll to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost $7.56 per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., $6.20 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton.....	$89.75
Tar pitch (in 400-lb. bbl.), per 100 lb.....	*7.03*
Asphalt roofing (in barrels), per ton, f.o.b. plant*.....	41.51
Asphalt felt (light), per ton, f.o.b. plant*.....	95.00
Asphalt felt (heavy), per ton, f.o.b. plant*.....	95.00

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 82 per cent; "A," 86 per cent; "B," 88 per cent. Double thickness "AA," 82 per cent, "A," 85 per cent; "B," 88 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10.....	$2.70@**2.80**	$3.90	$3.80	**$4.20**	$3.89
No. 12.....	2.80@**2.90**	3.95	3.85	**4.25**	3.94
No. 16.....	2.90@**3.00**	4.00	3.95	**4.30**	3.99
No. 16.....	3.10@**3.20**	4.10	4.15	**4.40**	4.09
Black					
*Nos. 18 and 20.....	3.45@**3.55**	4.45	4.30	**5.05**	4.55
*Nos. 22 and 24.....	3.50@**3.60**	4.50	4.35	**5.10**	4.60
*No. 26.....	3.55@**3.65**	4.55	4.40	**5.15**	4.65
*No. 28.....	3.60@**3.70**	4.65	4.50	**5.25**	4.75
Galvanised					
No. 10 and 11.....	3.75@**3.85**	4.65	4.50	**5.75**	**4.75**
No. 12 to 14.....	3.85@**3.95**	4.75	4.60	**5.35**	**4.85**
No. 16.....	4.00@**4.10**	.....	.....	.....	**5.00**
Nos. 17 to 21.....	4.15@**4.25**	5.05	4.90	**5.65**	**5.15**
Nos. 22 to 24.....	4.30@**4.40**	5.20	5.05	**5.80**	**5.30**
*Nos. 25 and 26.....	4.45@**4.55**	5.35	5.20	**5.95**	**5.45**
*No. 28.....	4.75@**4.85**	5.65	5.50	**6.25**	**5.75**

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Feb.5	New York: One Year Ago	Chicago: Feb. 5	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)....	**$1.26**	$0.95	$1.25	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound, f.o.b. New York:

	Dry		In Oil	
	Feb. 5	1 Yr. Ago	Feb. 5	1 Yr. Ago
Red	$16.25	$14.50	$17.75	$16.00
White	16.25	14.50	16.25	14.50

Lumber

Prices wholesale, per M. ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$28.00	$29.00	$30.00	$33.00
3x6 and 8	28.00	29.00	30.00	33.00
4x4-6 and 8	28.00	29.00	30.00	33.00
3x10 and 12	28.00	29.00	30.00	33.00
3x14	34.00	32.00	34.00	36.00
4x10 and 12	28.00	29.00	30.00	33.00
4x14	34.00	32.00	34.00	36.00
	24 Ft. and Under		25 to 32 Ft.	33 to 40 Ft.
6x10	$30.00		$32.00	$34.00
6x14	35.00		37.00	39.00
8x10	30.00		32.00	34.00
8x14	36.00		37.00	39.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$45.00	$46.00	.....	.....
3x10 to 10x10	48.00	49.00	.....	.....
3x12 to 12x12	55.00	56.00	.....	.....
3x14 to 14x14	60.00	61.00	.....	.....
3x16 to 16x16	67.00	68.00	.....	.....
3x18 to 18x18	.....	.....	.....	.....
4x20 to 20x20	.....	.....	.....	.....

* Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under; for sizes over 12x12 add $2; for merchantable add $2 to sizes 10x10 and under.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$52.00	$50.00†	$50.00	$50.00	$62.00	$60.00†
Seattle	.....	29.50	.....	.....	.....	23.50
New Orleans	32.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	40.00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	37.00	.....	.....	.....	38.00
Denver	.....	38.75	38.75	.....	.....	39.75
Minneapolis	42.00	39.75	39.00	.....	44.50	39.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	52.25	.....	.....	.....	56.00	.....
Kansas City	42.50	31.00	.....	.....	53.50	32.00
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	60.00	32.00	39.00	39.00	68.50	32.00
Detroit	47.75	52.75	.....	.....	57.75	52.75
St. Louis	39.00	.....	.....	.....	51.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$45.00	$43.00†	$44.00	$50.00	$48.00†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	80.00	.....	.....	42.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	38.00	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	32.00	.....	.....	81.00
Denver	.....	35.25	35.25	.....	33.75
Minneapolis	44.00	37.75	35.50	38.00	35.25
Atlanta	19.00	.....	.....	29.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City	77.00	73.00	.....	65.00	74.00
Birmingham	63.00	.....	.....	63.00	.....
Philadelphia	33.50	31.00	38.00	62.00	32.00
Detroit	38.75	39.00	.....	46.50	39.75
St. Louis	45.00	.....	.....	32.00	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Feb. 5	One Month Ago	One Year Ago
$2.05@2.15	$1.95@2.05	$2.65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arisona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.18@.22	New Orleans	$0.23½
New York	.22	Los Angeles	.19
Chicago	.21½	Seattle	.17
Minneapolis	.25½	St. Louis	.23
San Francisco	.23	Montreal	.16
Atlanta	.23	Detroit	.19
Denver	.25	Baltimore	.18
Cincinnati	.21	Kansas City	.20½
Dallas	.30	Birmingham	.19@.21
Philadelphia	.19		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.225	.25
Kansas City	.22	.245
Seattle	.165	.19
Chicago	.1525	.1775
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1875	.2125
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.23	.255
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. New York:

Sulphate of aluminum, in bags, per 100 lb	$1.40@1.45
Sulphate of copper, in bbl., per 100 lb	4.65@4.75
Soda ash, 58%, in bags, per 100 lb	1.25@1.45
Chlorine, liquid, cylinders, 100 lb., per lb. (f.o.b. works)	.05½@.07½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	1.90

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.19	St. Louis	.43
Denver	1.15*	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.